

NOTE ON IRRIGATION
IN THE
JHALAWAR STATE,

BY
THE CONSULTING ENGINEER FOR IRRIGATION IN
RAJPUTANA.

1903.

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1. Showing Drainage Areas of the main rivers.
2. To illustrate proposed diversion of small nullahs and the storage of water in village tanks.

NOTE ON IRRIGATION IN THE JHALAWAR STATE.

Area.—The Jhalawar State is about 69 miles long and varies in width between 5 and 17 miles. The area is 808·763 square miles. The height above sea level varies from 1,000 ft. in the Patan Tehsil to about 1,500 ft. in the Dag Tehsil.

2. Two of the main rock series of India are well exposed. Jhalrapatan, the capital, stands on Vindhyan strata at the northern edge of the great spread of basaltic rocks known as the Deccan trap formation, this northern area of it being also often mentioned as the Malwa trap. The beds about Jhalrapatan are considered to belong to the Rewa or middle group of the Vindhyan and consist of sandstone and shales, with a band of limestone. Over the greater part of the Vindhyan area, the strata are quite undisturbed, and their habit is to weather into scarped plateaux or ridges, having one face steep and the other sloping. These are capped by the sandstone, the lower ground being eroded out of the shales. Close to Jhalrapatan, however, a sharp axis of disturbance passes from the south-east beneath the trap to the north-west, throwing the beds up in an anticlinal form, with dips of 70 to the north-east and south-west. Along this steep out-crop the sandstone weathers into long narrow ridges. In these ridges occur some narrow openings through which rivers have cut their way, affording sites for grand irrigation projects; as these are now in the Kotah territory, they will be alluded to in the Note on Irrigation in that State.

The main area of the State is situated on a raised plateau, which lies rather more than 1,000 ft. above the sea at the north, and gradually rises to 400 or 500 ft. more to the south. The northern, eastern, and a portion of the southern part of this area are very hilly; these parts are intersected with streams of various sizes, affording many capital sites, some of which have been already taken advantage of, for damming up the water to form small lakes.

The rest of this area is a rich plain, undulating in parts and affording valuable land for cultivation. The soil is rich, divided into three classes: *kali* the black, the *dhamni* of a lighter colour but equally prolific, and *lal-pili* a yellowish red soil, the poorest of the three. It is estimated that about one quarter of the culturable area consists of *kali*, half of *dhamni* and one-quarter of *lal-pili* soil.

In parts the presence of rock and kankar close to the surface interferes with the productiveness of the *kali* and *dhamni* soils, and accounts for some of the tanks not holding up water.

3. **Rainfall.**—The average rainfall for the six years ending December 1903 is as follows, —

1898	...	33·15 inches.	1901	...	22·84 inches.
1899	...	18·86 "	1902	...	28·77 "
1900	...	59·20 "	1903	...	34·48 "

A statement showing rainfall monthly for 10 years is attached (Appendix I.)

N B—Much of the information given at the beginning of this Note is taken from the Local Gazetteer

The Jhalawar State depends greatly upon the kharif crops for its revenue; years of deficient rainfall, therefore, affect it seriously, and although famines are almost unknown, yet after the year 1899, when the rainfall varied from 14.5 inches to 20.76 inches, there was great loss of life and much suffering.

4. Ploughing for the autumn crop begins at the end of May, when the soil is once turned, and is thus in a state to derive benefit from the thunder-showers which generally precede the rains. After the first burst of the rains the soil is again turned and sowing begins. Land lying fallow during this season for the purpose of receiving spring-crops is ploughed three or four times, and gets thoroughly saturated with moisture; it is then in a fit state to grow wheat without the help of irrigation. Opium receives eight or nine waterings, at first daily and then at intervals of seven or eight days. Rich irrigated land has in the autumn either *maka* or *jowar* sown on it, which in the spring is followed by opium.

On the supposition that the cultivator gives his own labour, *i.e.*, deducting the cost of wages, it is calculated that a raj bigha of opium costs about Rs. 12 to produce; if labour be hired the cost is calculated at Rs. 20. *Maka* is calculated to cost Rs. 2-3-0 per raj bigha, *jowar* Rs. 1-10-0 and wheat Rs. 2-12-0; the last three are calculated on the supposition that labour is partly hired. *Maka* being mostly grown on opium ground, the manure given to the former suffices for the latter. The manure given to wheat and *jowar* is supposed to be enough to last for four or five years in the black soil.

5. Wells. — There are 7,996 wells in the State. (See Appendix II). Irrigation is chiefly from wells; water is generally near the surface, but the amount of land irrigated is small, owing to the absence of fertile springs and to the wells not being deeply dug on account of hard rocky strata, or layers of moist unstable clay being met with close to the surface. A *kutchra* well is said to cost from Rs. 20 to Rs. 30, a *pucca* well from Rs. 200 to Rs. 500.

The total area in the year 1900-1901 irrigated from wells is stated to be 12,162 acres, or about $1\frac{1}{2}$ acres on an average for each well; in 1901-1902 it was 11,353 acres.

6. Population. — In 1891 the population was stated to be 142,613; in 1901 it was 90,175, showing a decrease of 52,138, nearly 40 per cent., attributable to the famine and sickness which followed. The number of villages is 410.

Tahsil.	Population.	Number of Villages.
Patan ...	87,016	120 includes 2 towns.
Pachpahar ...	9,313	60
Awar ...	9,240	41
Dag ...	16,167	71
Gangdhar ...	18,439	100
Total ...	90,175	410

7. Revenue—The average land-revenue is Rs. 4,65,914 Hali-rupees.* In 1899-1900 (the famine year) it was about Rs. 3,50,000. The first instalment of 4 annas is due in December, so that the State has to rely on the closing balances of the past year until then; 6 annas are due in March and the remaining 6 annas in June. This accounts, perhaps, for shortness of funds just now.

8. The average yearly cultivated area in the kharif is about 185,000 bighas; in the rabi about 26,000 bighas. The kharif area is therefore about seven times that of the rabi; this shows how greatly the prosperity of the State depends upon the kharif, or in other words on a good and timely rainfall.

CLASSIFICATION AREAS.

	A.D., 1900-1901.	1901-1902
Forests	5,146	5,146.
Not available for cultivation ...	95,819	95,819.
Culturable waste other than fallow ...	11,690	11,690.
Current fallow	148,954	168,574.
Net area cropped during the year ...	93,678	75,681.
Total acres ...	355,287	356,910.

The large areas lying fallow and the culturable waste show how much the revenues of the State might be increased if cultivators could be induced to settle.

9. To induce cultivators to come it would pay the State to offer land on very liberal terms, and to let the offer be widely known. Small tanks in selected areas might be tried, and a few wells made below them by the State, wherever persons can be found willing to settle. Something is required to give them a fixed and sure hold and hope for the future. There are large tracts of good land only waiting to be cultivated. The gain in revenue and prosperity to the State would be sure and good. The State, it is said, is quite prepared to do this. Some 7 or 8 villages in Tehsil Patan and one in Tehsil Panchpahar have already, it is stated, been given out on easy terms; villages that formerly used to be worth much more have been rated at even less than half the former value, in some cases a nominal value only, and last year the rents of all uncultivated lands, it is said, were struck off the holdings of the cultivators, so that they have now only to pay the rent of the cultivated area. These measures show the liberal treatment of the Durbar, but must seriously affect the revenue.

Cultivators, it is said, sometimes have come from outside; have taken advances and then cleared off elsewhere. This shows some of the difficulties that have to be met.

10. Rivers.—The principal rivers are the tributaries of the Chambal running north:—

1. The Kali Sindh, along the eastern border of the State.
2. The Au, which divides Jhalawar from Gwalior. Ton and Indore on the east and Kom Kotah on the west.

* C Rs 1,00 = 118 Hali rupees.

3. The chota Kali Sindh, which flows through the Tehsil of Gangdhar.

4. The Chambal on the borders of the Gangdhar Tehsil.

The map attached shows the drainage areas of each and some of the tanks existing and proposed in each area.

It is doubtful if these drainage areas have all been systematically investigated.

In some of the rivers in these drainage areas the villagers have hitherto been in the habit of drawing water from pools or springs at the banks, but owing probably to the recent years of scanty rainfall in many cases the pools are said to be dry, and the springs in the river beds, it is said, have failed to furnish an adequate supply.

Storage reservoirs on these rivers or streams would, of course, do great good, and if in time the springs do not recover their normal supply, it might in some cases be worth while, if suitable ledges of rock occur, to build low weirs across some of these places, and so create artificial pools to supply the deficiency; where the beds are rocky, and stone therefore at hand, this might perhaps be done at small cost. This should be borne in mind.

11. Tanks.—Around and near Jhalrapatan a fair amount of irrigation is carried on from bunds. In the districts there are several bunds, but, it is stated, want of attention to them has rendered them more or less of little value.

Mr. Tickell, late State Engineer, in his Report gives a list of the principal works constructed by State or unprofessional agency. (See Appendix III.)

He states a large proportion of the tanks are merely village ponds and unfit to be called irrigation works, and incapable of being improved to render them famine insurance works. Thus three tanks, at Patan, Gaonri and Dhanwara are good; out of 120 others only about six, he states, are worth improving.

This is an important point and deserves careful investigation, as money cannot be better laid out than in repairing or improving existing works, if they are capable of being improved, or enlarged, or the supply to them can be made certain every year, by a cut from any nullah near. They often benefit wells below them. The reported expenditure on the three principal works is said to have been about three lakhs, the area irrigated on an average only 1,062 bighas and return about Rs. 2,465 average annually. (Appendix IV).

It seems as if these results might be improved. As regards modern irrigation works, those completed during the last few years are shown in Appendix V. Only two tanks are noted and only one is an irrigation work, viz., the Durgapura Tank. This appears to be a very successful work and pays Rs. 14 per cent., notwithstanding the fact that in years of deficient rainfall it does not fill.

Mr. Tickell rightly observes, "as much better sites for tanks than that at Durgapura are available in various parts of the State, the Durbar may extend its irrigation works with absolute confidence of a profitable result." The Durbar have, in fact, lately made some small tanks at Singpura, Khandar, and Kholkheri in the Awar Tehsil—and these are stated to have proved a complete success; this ought to give encouragement.

12. Irrigation Works in hand.—The principal irrigation works in hand are described in Appendix VI. The Consulting Engineer for Irrigation, at the request of the Durbar, has inspected each of these, and his remarks on each are attached. (See Appendices).

The undermentioned four tanks, although constructed for the most part by famine labour, are good examples of economical irrigation works:—

<i>Estimated Cost. Rs.</i>			<i>Estimated Cost per million c. ft.</i>	<i>Water stored per Rupee.</i>
60,846	1.	Mondlakheri Tank ...	165	5,785 c.ft.
12,186	2.	Stratton Tank ...	184	4,924 "
28,242	3.	Kishanpura Tank ...	258	3,272 "
12,168	4.	Hathonia Tank ...	158	6,795 "

which is exceptionally good, taking it for granted that these figures are correct; and if the water is properly used, these tanks ought to pay well.

13. The main object of the visit of the Consulting Engineer for Irrigation is to give advice generally on irrigation matters, and particularly on any projects which may be laid before him. Time does not admit of his investigating every drainage area and searching for sites himself. Nothing would be more delightful than to be able to do this, and to know that there are funds and the desire to carry out grand projects; for no doubt, some grand projects do exist—but it is necessary to adapt suggestions to local conditions; it is for this reason the foregoing remarks have been noted.

Unfortunately the late State Engineer (Mr. R. H. Tickell) who evidently knew the value of irrigation, and took an interest in the subject, is not here now, so the Consulting Engineer feels at some disadvantage in not having the benefit of his local knowledge and experience; he has only Mr. Tickell's maps and report to guide him. Allusion will be made to these hereafter.

14. There are certain facts which strike one at the first glance such as—

1. The great extent of good land lying fallow.
2. The many excellent sites that exist for storing water in almost every part of the State.
3. The quantity of water which annually goes to waste, and which, if it could be stored and utilised would probably be enough for all the needs of the State.
4. That very little has really been done yet in the way of irrigation.

5. That water can be stored cheaply, and under good conditions it brings in a good return, *vide* Durgapura, which is said to pay Rs. 14 per cent. (Appendix V.), and the tanks lately made by the Durbar and alluded at the close of para. 11.
6. The serious loss which the State has suffered lately both in population and in cattle, owing to the recent famine, and the difficulty in getting people to take up the land and cultivate.
7. That the resources of the State financially are very limited, and that without help there is no hope of much being done.

It is no doubt for these reasons (6) and (7) principally that more has not been done lately.

Appendix VII shows the amounts which have been expended in the last 4 years on irrigation. The average expenditure has been about Rs. 22,670; most of this expenditure, however, was in the years 1900 and 1901, during the famine, and the Durbar deserves credit for the liberal expenditure in those years. In the current year, Rs. 8,000 have been sanctioned; this is not enough to do much.

15. The present Asst. Engineer in charge of the Public Works and Irrigation, has not had much practical experience, and is new to the State, and perhaps has not felt able to initiate much at present. This may also account partly for the small progress lately. He appears, however, to be energetic and willing and to take a keen interest in Irrigation, but he has no Surveyors or any establishment under him for getting up new projects. The cost of establishment falls at present about $\frac{1}{4}$ of the total expenditure. He is able to do much more work and is quite willing to do it. He could very well supervise the work of three or four Surveyors.

16. If the resources of the State do not admit of large irrigation projects being carried out at present, it is not of much use to suggest them, but there is no reason why smaller works should not be prepared; and while some are being carried out, the Surveyors could be employed in preparing others. This appears to be the first step necessary. If any of the larger streams can be tapped so as to ensure tanks being filled every year, then they will be an insurance against famine for the villages under their influence; and this of course is what should be aimed at.

17. The Consulting Engineer was requested to see the following works or sites:—

Mandlakheri Tank	...	...	(Appendix VIII)
Stratton Tank	...	...	(IX)
Kishanpura Tank	...	...	(X)
Hathunia Tank	...	...	(XI)
Rewa River Tank	...	...	(XII)
Panchpahar Tank	...	...	(XIII)

And the Kali Sind River Bund, site at Sarwar.

He has seen all the above, with the exception of the last, and his remarks on each will be found in the Appendices.

The reasons for not inspecting the Sarwar Site were because nothing definite had been decided about this project. No surveys have been made yet, nor any date provided, upon which an opinion could be given. The project is roughly estimated to cost Rs. 1,50,000, and it is said the State will not be in a position to carry out any large work of this sort for many years. No surveys or levels have been taken for the canals, and it is impossible to say what land can be irrigated. Judging from an inspection of the map, the land over which any canal must pass on either bank is much cut up by cross drainage, which would interfere with irrigation, and be expensive to cross; and it seems very doubtful if there is sufficient land to afford an adequate return on such a large outlay.

Under the circumstances it appeared to the Consulting Engineer waste of time to go so far, when there is so much to be done nearer, as this Report will show.

The Consulting Engineer also inspected sites—

Near Garuria	...	...	( Appendix XIV)
Moria broken bund	...	...	( „ XV)
Old village tanks at Ramnewas Ghatod,	(	„	XVI)
Shamia—proposals for Maharani's vil-			
lage of Shamia	...	...	( „ XVII)
Deori—suggestions for irrigation near			
Deori, with a map	...	...	( „ XVIII)
Durgapura	...	...	( „ XIX)
Sarangakheri	...	...	( „ XX)

Remarks on each of these are given in the Appendices.

18. A reference is invited to the remarks on the suggestions for irrigation near Deori (Appendix XVIII) because the Consulting Engineer thinks that it may serve as a typical example, applicable if found to be possible, of what may be done in many other places in the State, and it is more in accordance with the present circumstances of this State than large and expensive projects which may, perhaps, be possible hereafter. Small tanks meet, too, with the approval of the Maharana, the Dewan and the Revenue Department, and the villagers; and have been exemplified in the case of the small tanks at Singpura, Khandar, and Kholkheri which have been lately made by the Durbar; these have, it is stated, proved a complete success.

It may be urged that small tanks are no insurance against famine. If it is possible to ensure them being filled every year by the means suggested, then they would be; and in many places it is hoped this may be done. But even if not, they will go some way towards ensuring a better supply to wells below, and in giving the people a better power of resistance. Half a loaf is better than no bread.

19. A reference to the late State Engineer's printed Report shows in Appendix E, in the programme for future consideration, 23 works on which, for an expenditure of Rs. 9,17,000, 75 villages, it is stated, would

be protected from famine, or about 23 per cent. of the total number of Khalsa villages in the State. The land-revenue would, it is stated, be raised from Rs. 4,66,000 to Rs. 56,400, the area proposed to be protected by irrigation being about 51,000 bighas.

It does not appear upon what data these calculations have been made. Only plans of four of these works and two estimates are forthcoming, and these are incomplete—not sufficient at least for a new and inexperienced Engineer to work upon. The canals apparently have not been surveyed in any project; nor can the sites be pointed out of many of the large projects even; nor does the question of compensation for land or wells submerged (if any) appear to have been considered. Some are in Jagir villages, and it is not known if the Jagirdars are willing or have been consulted.

It may be that the late State Engineer only intended this statement as a rough guide to what he believed would be realised; and however much one might wish these hopes to be realised, it is impossible to recommend a State to take up costly projects of this sort on such imperfect data.

There is nothing to show that every drainage area has been thoroughly investigated and that the best sites have been selected, or that the Revenue authorities have been consulted and approve. Judging from the places which the Consulting Engineer has inspected, he considers it would be necessary to have proper plans and estimates prepared in every case, before taking up any of these projects. At present, with the small establishment and the small annual grant, it is impossible to expect much. It is in this direction the State can best devote its efforts, if it is really desirous of promoting irrigation, viz., in the preparation of projects, so as to have well-considered schemes ready to take up whenever required; and to be able to select the best, and to know which to begin first—to have in every case permanent bench marks fixed on the ground and plans and estimates recorded.

Whether a bold policy is to be adopted as regards construction, and it is hoped this may follow, there can be no question as to the need of an energetic policy, as far as the preparation of projects is concerned.

This does not commit the State to any large outlay, and may save wasteful expenditure hereafter. It would be the first step necessary in any case, and as a preparation against famine, after what has occurred, it seems very necessary. Large works take some time to prepare and longer to complete, and only when completed can any return be expected. Irrigation takes time to develop. The expenditure would be all in one place, and until completed the item of interest on the outlay would have to be considered.

20. The need of professional help in carrying out irrigation works appears from an inspection of Appendix B. in the printed Report of the late State Engineer. If these figures are correct, it appears that on the three best works the expenditure is said to have been about three lakhs,

the irrigated area to be only about 1,062 bighas and the return only Rs. 2,465, not one per cent even; and yet the Durbar have lately done cheaply successful work. (See para 18).

21. As regards the cattle, whether it would have been possible to prevent altogether the great mortality that occurred during the recent famine, it is difficult to say, but grass in ordinary years is plentiful, and it would be a wise precaution to have some of it stacked, if possible, every year near every village; so that in case of a failure of the following rains, there would be reserves of grass to feed the cattle in every village. Loss of cattle means decreased cultivation afterwards, even if the rains are good. Every village appears to have suffered and the number of ploughs to be sadly reduced.

No attempt has been made to inspect any sites in Jagir villages, as until the wishes of the Jagirdar are known, any action of this sort might be misunderstood.

22. The Raj Rana himself and his Dewan appear to take a keen and intelligent interest in Irrigation. They have both discussed the subject of Irrigation with the Consulting Engineer, and have expressed the readiness of the State to go heart and soul into the work, but at present no funds are available, and until they are forthcoming it is impossible to expect any real progress to be made. The most the Consulting Engineer can do is to make suggestions; if these are properly acted up to, he is confident that a right beginning will have been made, and that the State will certainly derive advantage from the policy proposed.

23.—Summary of suggestions—

(1) The necessity of financial help. Until funds can be provided it is hopeless to expect much to be done.

This is a problem which must be solved by the Political Officers and the Durbar, if any real progress in Irrigation is to be made.

(2) A fixed policy should then be adopted. A certain sum should be set apart annually for Irrigation (if it may be permitted to make a suggestion), of not less than 10 per cent. of the revenue.

The amount set apart should be independent of all other considerations and be used only for Irrigation. The money would be all spent in the State and would naturally add to its wealth, and would eventually be returned in increased revenue.

(3) Professional help is required. Good Surveyors and establishments under them should be provided, to systematically prepare small projects at first, in consultation with the Revenue officials. The first year might be spent in preliminary work, which would not necessitate any large outlay. If proper provision is to be made against famine, such measures would be necessary in any case. The next year the best of these projects might be carried out, and the Surveyors be employed in preparing other projects.

* Since writing the above, the Dewan has informed the Consulting Engineer that being made to get two Surveyors.

(4) As these projects are prepared they should be registered and the records kept ready to be taken up at any time.

The Bench marks on the sites should be made permanent, so that there would be no difficulty or delay in starting any work when the order was given.

(5) The sort of works which are recommended are—

- (a) Repairs or improvement of existing tanks.
- (b) New village tanks wherever the necessity and benefit is admitted by all.
- (c) The diversion of water courses to fill existing or proposed tanks, as suggested in para. 18 and Appendix XVIII.
- (d) The extension or improvement of ducts to existing tanks so as to increase the value of water which has been already stored.
- (e) Where necessary, the improvement of pools in rivers to increase, by percolation, the supply of water to wells below at the banks of the river. See para. 10.
- (f) The improvement of existing wells wherever necessary, by deepening them; or by the construction of new wells by the State, below existing or proposed tanks, wherever the Revenue authorities are of opinion that such are necessary. Nearly all the wells are in rock, and where water fails only require to be deepened a few feet to be efficient; as a rule water is everywhere near the surface.
- (g) The construction of small pucca submerged weirs across streams with rocky beds, where the water flows long enough to make it worth while to lead it off for irrigation; if it can be taken to culturable land at a reasonable cost.
- (h) Accounts to be kept of all works carried out, showing the original cost, the amount spent on repairs, the area and crops irrigated and the amount realised annually.
- (i) A report to be submitted annually showing what progress has been made during the past year. Wherever a State has done its best there would naturally be no objection to this.

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Consulting Engineer for Irrigation in Rajputana.

January 1904.

APPENDIX I.

Statement showing the Rainfall for 10 years, Jhalawar State (Rajputana):

	MONTHS.	YEARS.									
		1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.
1	<i>Chaoni.</i>										
	January	6.10	1.38	1.0	0.62	...	...	...	0.23	0.40	0.63
	February	0.28	...	...	...	6.19	...	...	0.09	0.04	...
	March	...	0.90	...	...	...	...	...	0.40	...	...
	April	...	0.02	...	...	...	...	0.70	...	...	0.06
	May	...	...	...	...	0.20	0.10	0.35	0.28	0.57	...
	June	17.62	3.52	10.05	4.67	3.39	11.79	0.92	0.57	0.08	0.53
	July	15.66	13.75	13.0	6.02	8.87	8.50	13.59	12.84	13.45	11.28
	August	2.77	15.34	9.93	15.46	8.54	0.37	28.49	18.49	8.31	11.92
	September	4.81	1.23	...	4.66	7.31	...	11.42	0.10	5.06	27.14
	October	0.01	0.36	...	...	...	...	...	0.04	0.53	0.50
	November	...	...	0.99	...	...	...	...	...	...	0.30
	December	...	...	0.50	...	1.60	...	0.42	...	...	...
	Total	42.18	36.50	35.47	31.03	30.40	20.76	55.89	33.04	28.44	55.39
2	<i>Patn.</i>										
	January	...	1.33	...	0.74	...	...	...	0.30	0.19	0.32
	February	...	0.06	0.10	...	0.49	...	...	0.85	0.05	...
	March	...	0.42	...	...	0.02	...	...	0.01	...	...
	April	...	...	...	0.02	...	...	...	0.06	...	0.06
	May	...	...	...	0.21	0.03	0.44	0.76	0.21	0.08	0.02
	June	...	7.07	9.04	6.50	3.51	7.20	1.55	1.08	0.09	0.99
	July	...	24.89	12.13	7.24	7.34	7.19	12.28	5.93	14.73	6.78
	August	...	22.67	9.45	14.43	7.92	0.62	29.59	22.39	7.91	12.36
	September	...	2.90	...	3.34	8.54	0.75	10.37	0.10	5.16	22.64
	October	...	0.10	...	...	...	...	...	0.04	0.21	0.52
	November	...	...	0.88	...	...	...	0.21	...	...	...
	December	...	0.10	0.67	...	1.53	0.35	0.48	...	0.12	...
	Total	...	39.64	32.37	31.51	29.41	16.55	55.24	31.04	28.47	43.73
3	<i>Panchpahr.</i>										
	January	...	1.17	...	...	...	...	...	0.32	0.75	0.27
	February	...	0.20	...	...	1.26	...	...	0.11	0.09	...
	March	...	0.08	...	...	...	...	...	0.05	...	...
	April	...	0.10	...	...	...	...	0.44	0.07	...	...
	May	...	...	...	0.15	...	1.33	0.02	...	0.05	...
	June	...	6.73	9.09	1.43	1.99	7.31	1.64	0.68	0.08	1.59
	July	...	5.53	5.84	6.07	8.44	5.95	9.54	4.05	18.52	8.09
	August	...	11.32	11.16	11.09	5.94	1.29	35.53	11.82	5.32	11.69
	September	...	1.91	0.08	2.26	3.87	0.15	10.35	0.43	4.30	16.52
	October	...	0.11	...	...	...	0.03	...	0.36	0.46	0.47
	November	...	...	2.27	...	...	...	0.11	...	...	...
	December	...	0.22	0.76	...	1.82	0.12	0.64	...	0.27	...
	Total	...	27.36	29.20	21.00	27.32	16.23	58.27	17.89	29.84	38.54
4	<i>Gangdhar.</i>										
	January	...	0.03	...	0.30	...	...	...	0.10	0.58	0.07
	February	...	...	...	...	0.55	...	...	0.11	0.02	...
	March	...	0.08	...	...	...	...	...	0.22	...	...
	April	...	0.11	...	0.03	...	...	0.24	...	...	...
	May	...	...	...	0.02	...	0.83	0.15	0.03	0.06	...
	June	...	8.07	9.49	3.87	1.70	7.71	5.75	1.47	0.92	2.50
	July	...	7.39	17.01	6.67	11.13	2.77	12.54	8.13	12.39	10.86
	August	...	13.80	26.18	8.90	12.24	0.95	26.06	14.86	10.02	10.62
	September	...	9.33	...	3.02	3.36	1.89	23.18	0.86	8.25	12.37
	October	...	0.76	...	0.70	...	0.20	...	...	0.93	0.62
	November	...	...	0.58	...	...	...	0.25	...	...	...
	December	...	...	0.72	...	0.41	0.15	0.21	...	0.63	...
	Total	...	39.87	53.89	23.50	30.31	14.50	63.36	26.78	31.97	37.04
5	<i>Dag.</i>										
	January	...	...	...	...	...	...	...	0.41	0.17	...
	February	...	...	...	...	0.75	...	...	...	...	...
	March	...	...	...	...	...	...	...	...	...	...
	April	...	...	...	...	...	...	0.12	...	...	...
	May	...	...	...	...	...	1.06	0.05	0.15	...	0.06
	June	...	...	...	...	6.01	11.79	0.61	0.64	1.84	3.72
	July	...	...	...	...	11.13	5.34	16.75	0.46	11.88	10.26
	August	...	...	...	...	10.06	0.10	31.20	13.76	3.32	6.07
	September	...	...	...	...	4.43	0.13	10.47	1.84	9.18	12.17
	October	...	...	...	...	...	...	...	...	0.89	2.03
	November	...	...	...	...	...	...	...	...	...	...
	December	...	...	...	...	0.77	0.22	...	...	0.75	...
	Total	...	...	...	...	31.15	18.86	53.20	22.84	28.77	34.45

APPENDIX IV.

Statement showing Area in Jhalawar State Irrigated by Tanks.

			SAMVATS.									
			48	49	50	51	52	53	54	55	56	57
1	PATAN.	Big.	Big.	Big.	Big.	Big.	Big.	Big.	Big.	Big.	Big.	Big.
	Dhanwara Tank	...	57	57	57	57	57	56	56	56	56	56
	Gaonri "	...	114	111	120	120	120	120	119	119	119	118
	Patan "	...	226	186	212	212	212	212	227	261	261	261
	Ramniwas "	...	26	26	25	29	29	29	29	30	30	30
	Semli "	...	42	49	46	46	46	48	48	50	50	50
	Deragpura "	..	403	403	403	406	417	425	426	426	438	439
	Kholkhanda "	..	16	16	16	16	16	16	16	16	16	16
	Stratton Sagar	...	...	...	...	...	...	...	...	...	...	...
	Kishenpura	...	...	...	...	...	...	...	...	...	...	...
	Naya Tank	...	...	...	...	...	...	...	...	...	...	...
	Total	..	884	851	879	885	897	906	921	961	973	972
2	PANCHPAHAR.											
	Misroli	...	...	...	...	...	...	...	...	...	...	...
	Sulia	...	...	...	...	...	...	...	...	...	...	...
	Hathunia	...	...	...	...	...	...	...	...	...	...	...
	Total	...	...	...	...	...	...	...	...	...	...	...
3	AWAR.											
	Singhpur	...	...	...	...	...	...	...	...	...	...	...
	Mahuria	...	...	...	...	...	...	...	...	...	...	...
	Total	...	...	...	...	...	...	...	...	...	...	...
4	DAO.											
	Pawanria	..	...	...	...	...	...	...	...	...	...	...
5	GANGDIHAR.											
	Dentakheri Tank	...	39	37	41	41	42	38	35	...	...	...
	Unel "	...	127	135	188	139	136	184	138	141	...	135
	Total	...	166	172	170	180	178	172	173	141	...	135
	GRAND TOTAL	...	1,030	1,023	1,058	1,065	1,073	1,078	1,084	1,102	973	1,107

Average 1,002 bighas.

APPENDIX V.

Principal Irrigation Works constructed by Professional Agency in Jhalawar, during the last 23 years.

Serial No.	Name of Works.	Site.	Capacity of Tank.	Percentage of 30" cut-off required to fill Tank.	Length and description of Bund.	Catchment area.	Average irrigated area and net revenue for 5 years ending July 1899		Actual Cost.	Number of years since completed & net profit to date.	Remarks.
							Bigha.	Revenue.			
1	Naya Talao	Charoni—Jhalapatani.	10 m. c. ft.	14	Masonry bund backed with earth 1,500 c. ft.	1 sq. mile.	About 10.	4,617 About Rs. 20.	Rs. 30,000.	22 years.	A small Tank constructed for the convenience of the people in Jhalapatani Charoni; not intended for irrigation.
2	Dugapura Tank	2 miles from Jhalapatani.	50 m. c. ft.	45	Masonry bund backed with earth.	2 sq. mile.	1,294	4,617	32,000.	22 years Rs. 30,000.	A very useful Tank, but owing to its small drainage area it does not always fill. The tank pays 14 per cent. and irrigates one village
							1,244	4,637	62,400	..	Total number of villages irrigated—1.

APPENDIX VI.

Principal Irrigation Works at present in progress in the Jhalawar State.

Serial No.	Name of Works.	Site.	Catchment area.	Capacity of Tank.	Percentage of 30' rainfall required to fill Tank.	Length and description of Band.	Estimated irrigated area and revenue.		Estimated Cost.	Expenditure to and of December 1900.	REMARKS.
							Bights	Rs.			
1	Mandlakeri Tank	...	Jhalrapatan City .. 25 square miles.	484 m c ft	22	Earthen bund 7,600 feet.	6,000	12,000	65,000	25,000	A very fine Tank, commenced during the Famine of 1900. It is a continuation of Patan Tank nearly finished.
2	Stratton Tank	...	Khandia suburb of Jhalrapatan 17 square miles.	65 m c ft	52	Earthen bund 2,100 feet.	800	1,600	12,000	8,000	The Site was selected by H. H. the Raj. Rana and named after Captain Stratton. Political Agent, Kotah and Jhalawar.
3	Kisheppura Tank	...	Kisheppura 4 miles from Jhalrapatan 34 square miles.	97 m c ft	40	Earthen bund 4,000 feet.	1,500	3,000	25,000	17,000	The site was selected by His Highness the Raj Rana.
4	Hathania Tank	...	Panchpohar Tehsil, 21 square miles.	82 m c ft	54	Earthen bund 2,900 feet.	1,800	3,600	13,000	7,000	Commenced during the Famine of 1900. Now nearly half completed.
5	Singhpur	...	Awar	...	..	..	...	...	...	...	About to be completed
6	Mahuria	...	Panchpohar	...	...	..	...	...	...	...
7	Kholkeri	...	Awar Tehsil	...	...	.....	...	...	...	...
8	Khandar	...	Do.	...	...	.....	...	...	...	...	Villages to be irrigated 12.
Total ..							10,100	20,200	1,15,000	57,000	

APPENDIX VII.

Memo. of Expenditure incurred on Irrigation Works, Jhalawar State, during the following years

Sl. No.	Name of Works.	Date of commencement.	Expended in 1900.			Expended in 1901.			Expended in 1902.			Expended in 1903.			Total up to Date.			Total yearly average.			Remarks.
			Rs.	a.	p.	Rs.	a.	p.	Rs.	a.	p.	Rs.	a.	p.	Rs.	a.	p.	Rs.	a.	p.	
1	Khandi khal or Stratton Sagar. ...	10th August 1899.	7,540	1	10	2,694	0	11	526	5	9	13	14	6	10,774	7	0				
2	Kisheupura Tank...	26th December 1899.	17,927	8	1	4,838	12	4	3,457	14	6	308	12	4	26,532	15	3				
3	Hathunia Tank ...	27th January 1900.	4,705	6	6	1,895	3	3	156	1	7	4	9	0	6,761	4	4				
4	Mandlakhari Tank.	23rd February 1900.	22,342	5	5	7,808	4	0	4,776	11	6	8,009	14	8	42,937	3	7				
5	Gaonri Tank ...	26th May 1900	2,808	15	3	869	0	9	...	Nil	...	...	Nil	...	3,678	0	0				
												Total		...	90,683	14	2	22,670	13	6	

APPENDIX VIII.

MANDLAHERI TANK

Catchment area 25 square miles, capacity 484 m. c. ft. Earthen bund 7,600 ft. long. Estimated cost, Rs. 65,000. Begun during the famine of 1900. It is a continuation of the Patan Tank, which it extends and improves, increasing its capacity from 132 m. c. ft. to 484 c. ft.; 406 m. c. ft. are available for irrigation.

The quantity of water stored per rupee is said to be 5,785, which includes the old tank. Top of bund above H. W. L. 5 ft.

The following points are noted :—

(1) *Coping to escapes.*—Suggests the joints although diagonal, if not through stones, should break joint.

(2) *Pucca bench marks* where not already put on the top to be put, to keep record of the finished height of the bund, and small slabs to mark every 100 ft. The height of bund above H. W. L. is only 5 ft., which is scarcely enough for such a large sheet of water; a west wind might wash waves over, if a storm occurred during a flood, when the tank was full.

It is important the top of the bund should be always maintained at its full height.

(3) *Interior slope.*—Cut up by wash of water in places, it is being covered with stone pitching, which is included in the estimate and is very necessary; a layer of small stone or kunker, about 3" thick, should be spread over the surface everywhere below the stone pitching, to prevent guttering of the earth by water passing between the larger stones of the pitching.

(4) *Leakage from chain 42 onwards in places.*—At this point the earth of the outer slope has fallen for a short distance; wherever leakage occurs I would suggest the toe of the outer slope should be protected by placing against it a small bank, say 4' x 3', first of fine sharp sand, then a bank of small broken stone, then larger rubble—the outer stone being large enough to remain fixed. This allows any leakage water to pass out clear, and keeps the earth in its place. So long as the water comes out clear there is no fear. A small catch-water drain too might be dug about 100 feet away from the toe of the outer slope, to catch and divert all leakage to the nullah. Owing to the rock below being only covered by a layer of earth, about 2 feet thick in places, there will probably always be leakage. I should have thought a small masonry core-wall let well into the rock everywhere would have been advisable, to prevent leakage and all fear of breaching. A masonry core-wall has been put for a short distance only.

The soil is good black earth. If any clods have been allowed in the earth-work and the tank is suddenly filled before the earth has thoroughly consolidated, there will be danger.

(5) There are a few longitudinal cracks in the earth which should be carefully filled up and rammed.

(6) The top of the bund should be higher on the outer edge than on the inner, so that surface rain water may flow towards the inner slope, else in the rains it may cut up the rear slope.

(7) Outlet sluices--

(a) The top of the wall should have a stone coping; at present it is masonry, and some small pieces of stone or gravel appear to have fallen, and one got wedged in the groove of the valve so that it could not be quite closed or the stone removed while we were present.

(b) The bed stone to which the top wheel of the outlet valve is attached requires to be firmly fixed, it is loose.

(c) A masonry core-wall about 15 ft. long should be added on each side of the masonry of the sluice channel, or water some day may creep along the sluice wall, through the bund, and cause leakage or a breach. This is most necessary.

(8) Waste weir at south end---

Where the overflow passes behind the bund on its way to the nullah, and flows parallel to the bund, it has cut into the ground at the toe of the rear slope: this should be protected by stone pitching.

The end of this weir nearest the bund might be made a foot higher than the other end, to cause the greater overflow at the end furthest from the bund.

(9) Regarding the irrigation ducts; on the right bank there does not appear to be much land commanded, the duct should be laid out with a slope of 2 ft. to a mile (5,000 ft.), and dug as far only as required for irrigation.

On the left bank, there is any amount of good land beyond and below the range of hills on which the Fort is situated, towards the north-east, below Gandher village.

From the point where good land begins, levels should be taken back along the left bank of the Chandra Bhaga Nullah until a suitable place is reached, from which the canal might start. The water from the lake could then be allowed to run down the natural bed of the nullah and be diverted by a small weir across it to the canal.

It is possible the road dam on the Asnaur Road may be made use of as the diverting weir, but if a suitable place can be found lower down where the nullah debouches from the range of hills, so as to admit of a canal being taken off right and left, and the levels admit of irrigation on both sides, that would be the best place. This should be investigated.

There is a likely place about 1,000 ft. below the above road dam and old bridge, where there is rock in the bed and the banks are well defined. Until, however, surveys have been made and levels taken it is impossible to say more.

APPENDIX IX.

Stratton Sagar.—Situated at Khandia, a suburb of Jhalrapatan catchment area, though only $1\frac{3}{4}$ square miles, is rocky ; capacity 65 m.c.ft ; an earthen bund 2,100 ft. long with a masonry escape in the centre 14 ft high, 200 ft long.

The tank is provided with two sluice wells fitted with wooden plugs, cost Rs. 10,774-7-0.

The left duct has been made for 39 chains only. The tank is almost full, and there is very good land below it.

It is said Rs. 2,000 are required to complete the system of ducts, Rs. 200 only have been sanctioned as yet. In order to get the full advantage of the work, there ought to be no hesitation in completing it fully. This tank has the benefit of all the leakage or percolation from the Gaonri Tank above it.

It ought to pay well. It appears 8,125 c.ft. have been stored for one rupee ; if these figures are correct, it is an exceptionally economical storage, and considering it was constructed with famine labour is a very creditable work.

APPENDIX X.

Kishenpura.—This is described in the printed report as a tank for the irrigation of Kishenpura, a deserted village, and Bilonia; it was begun during the famine of 1900, and is practically completed. As much fertile land is commanded, it ought to pay a good return. The site was selected by His Highness the Raj Rana. The drainage area is $3\frac{1}{2}$ square miles, and although it has filled and overflowed, it may not always fill. It is stated to contain 97 m.c ft. The bund is of earth 4,000 ft. long, the inner surface is pitched with stone for the greater part, and is estimated to irrigate 1,500 bighas, and to give a return of Rs. 3,000. It is stated to have cost Rs. 17,000.

If a nullah which passes the village of Bilonia, a small hamlet in the hills about $1\frac{1}{2}$ miles distant north-west, is diverted into the tank, it would cost, it is stated, about Rs. 10,000, and would increase the catchment to $4\frac{1}{2}$ miles.

It was to see this nullah, near Bilonia, that Khan Sahib Sheikh Subhan took us round to the village. The gorge is not suitable for bunding up, as it is comparatively wide and there is no good storage basin: any attempt at diversion would have to be made where the nullah debouches on to the open ground, and would have to be large enough to carry off all the water and would be an expensive work.

The necessity for any action at present in this matter is not apparent, and it will be time enough to think of it when the demand for the water is greater than the supply.

A less expensive method of increasing the supply would be to put small masonry piers on the waste weir, fitted with cut stone grooves, into which planks could be let down when the water began to cease overflowing, and so a foot or two extra height of water be retained above the present H. W. L.

The following points are noted:—

- (1) Where the water has fallen over the escape the ground and been cut up, good stone pitching should be placed about 10 ft. wide, two feet deep let into the ground, so that the upper surface shall be flush with the ground.
- (2) The inner slope where it has been cut away or sunk should be re-made up to the proper slope, and be pitched with stone where necessary.
- (3) Right duct should be marked out at a slope of two feet in the mile and be made as soon as possible. It should be made five feet wide at first and widened hereafter if necessary.
- (4) Outlets should be provided to enable the Zemindars to take water where required without having to cut the bank. There may be earthen or stone pipes through the bank with a stone or masonry face fitted with a wooden plug.

If the water is found not to flow fast enough through these openings, they must be made larger, or sluices be put at intervals across the main duct to head up the water.

These cross sluices would consist of masonry walls across the main duct, leaving an opening in the centre, with cut stone grooves on each side to allow small wooden planks to be inserted to any required height.

- (5) Bench marks in the bed and distance marks on the canal bank should be put to facilitate reference.
-

APPENDIX XI.

HATHUNIA TANK.

At Hathunia found the proposed bund about $\frac{1}{3}$ completed. It was begun in the late famine to afford relief, and, it is said, about 500 persons were employed.

It is described by Mr. Tickell, the late State Engineer, as follows:—

Hathunia Tank.—"Panchpahar Tehsil catchment area 21 square miles, capacity 82 million cubic feet, will fill with $5\frac{1}{2}$ per cent. of a 30" rainfall. An earthen bund 2,900 feet long, estimated irrigated area 1,800 bighas, estimated revenue Rs. 3,600. Estimated cost Rs. 13,000, a tank for the irrigation of three villages, commenced during the famine of 1900. The site is most excellent, and the bund can hereafter be raised and extended, if found advisable, to form a tank of 150 to 200 million cubic feet. The tank should pay from 20 to 27 per cent."

H. H. the Raj Rana has, I understand, seen the place, but the Assistant Engineer had not been here before.

The following points appear deserving of note:—

- (1) The escape is shown on the plan as a masonry wall, the place where it is proposed to build it is good black soil, but there is no rock, and there is no water cushion or pitching below. If a heavy flood passes over it there is likely to be damage; a good bed of dry rubble stone about 15 feet wide 2 feet deep should be let into the solid ground to break the force of any falling water, and to prevent the ground from being scoured out below the wall.
- (2) It is stated that if found advisable hereafter to raise and extend the bund it will be possible to do so. The masonry wall of the escape should be made of such a section as to admit of it being raised hereafter.
- (3) The south sluice outlet has not been begun yet. The masonry channel through the bund for the sluice on the north side has been built, but the well on the water side has not been made yet. The plans for these sluice outlets should be prepared. A masonry core-wall across the masonry tunnel does not appear to have been provided. It is advisable to have this always put, or water may some day percolate along the masonry surface and cause a breach.
- (4) In nullah crossing the loose bajri should all be removed and good black soil put instead.
- (5) The greatest care should be taken to trench well into the bed of the nullah, and into the sides of the existing work, and into the surface of the ground, to ensure the new earth uniting firmly with the old work. Wherever weeds or grass have sprung up on the surface of the old work, these should be removed and the surface dug up for the same reason.

- (6) Bench marks should be fixed at each, and at intervals, to ensure the earth at the top of the bund being always kept up to the proper height. Marks should also be put at every chain or 100 feet to facilitate measurement and reference at any time.
- (7) The plans do not show if any cultivated lands or wells of villages above Haramtia and Hathunia will be submerged. The H. W. L. should be marked out on the ground, and these points should be ascertained and noted on the plans and compensation be included in the revised estimate.
- (8) The irrigation ducts are not shown on the plans, and it is said they have not been laid out yet; they should be laid out on the ground at a slope of 2 feet in the mile and be entered on the plan for record.
- (9) A revised estimate should be prepared at once showing how much will be required to complete the work.

It is stated that about Rs. 6,761 have been already spent, but that last year only Rs. 300 to 400 was spent through the Tehsil, and when the rains fell that all work was stopped, and has not been resumed.

Until the work is completed and irrigation begins, there will be no return on all the money already laid out; and all the water which might have been stored to benefit the country goes to waste. This ought to be sufficient to show how desirable it is to complete works that have been begun.

I strongly advise the work being pushed on at once, or another year's rains will be lost.

If the figures given are correct, it shows that about 6,795 cubic feet of water will be stored for a rupee, which is exceptionally good, and there ought to be no doubt of the work bringing in a good return if it is carried out properly and irrigation encouraged.

APPENDIX XII.

REWA RIVER TANK.

Mr. Tickell, late State Engineer, has entered the following note in his printed Report about this project :—

" Rewa River Tank.—Imlia Kheri, catchment area 70 square miles ; capacity of tank 300 m.c.ft ; percentage of 30" rainfall required to fill the tank 6 ; masonry bund backed with earth 12,000 ft. long ; estimated irrigated area 5,600 bighas, estimated revenue Rs. 11,200 ; estimated cost Rs. 90,000 ; estimated profit on the cost 12 per cent. : a tank to irrigate 9 villages, of which 4 are Jagir, with 2 canals totalling 12 miles, one on each side of the river."

On reaching the village of Khod, close to a few deserted hut-, said to be Imlia Kheri, we got some of the villagers to go with us, but no one could give any information whatever as to the site selected, or if any surveys even have been made ; nor could we find any bench marks or anything to help us. We examined the river bed for about a mile above Khod. Rock crops out in three places, one at Khod itself, which is situated on a high bank ; another a little above the deserted hamlet on one side, and about half a mile above it, just above the point where a nullah from Khejra Khal on the left joins the river.

On the 14th January the river was again examined from Bondpur down stream until this last point was reached. Apparently this seems to be the best place so far as the river itself is concerned.

There appears to be rock also on the higher ground for an escape, but it is not clearly defined, though probably not far below the surface. Trial pits would be advisable at intervals along the proposed line to settle this point, which is important

Until cross sections have been taken and sufficient information collected to admit of comparison, it is impossible to say which is the best place to adopt.

The following points will have to be borne in mind :—

- (1.) Which place admits of the best foundation across the river.
- (2.) At which place can the best escape be provided, remembering that if good rock can be met with, it will be cheaper and better than having to build a masonry escape in the river.
- (3.) At which place will the least damage be caused by submerging the land inside.
- (4.) What land will be commanded on both banks by canals laid out with a fall say of 2 ft. in the mile, and how much is Khalsa ?

- (5.) Can the canals be made without much expense or difficulty in crossing drainage?
- (6.) What will be of each the cost, the capacity and the probable return?

When the above information is obtained, it will be possible to form a fair opinion as to which site should be adopted.

The River Rewa is a fair river about 150 ft. wide, and from the flood marks must flow sometimes 15 to 20 ft. deep. At either of the above places a bund would form a grand lake, as the basin appears to be a large and good one, but it is a large and costly project and should not be undertaken without careful consideration. It seems to be a good project, and I would recommend the surveys and estimate to be taken in hand as soon as possible.

APPENDIX XIII.

PANCHPAHAR TANK.

PANCHPAHAR.

13th January (continued)

At 7½ A.M. walked with the A. Engr., and Kanungo, Jai Behari Lal, to see site of tank proposed by Mr. Tickell, across the nullah which flows past the village. It is described in the printed Report as "Panchpahar Tank. 20 sq. miles. catchment area; an earthen bund 10,000 ft. long: capacity 200 m. c.ft; percentage of 30" rainfall required to fill it 14, estimated cost Rs. 60,000: estimated area it would irrigate 3,400 bighas: estimated revenue Rs. 6,800, which would represent 11 per. cent. as the estimated return."

"A tank to irrigate 5 villages. The site is a most excellent one and the remains of a small old tank exist here."

Madho Singh, the Lumbardar of Panchpahar, and the Kanungo came with us, the latter pointing out the line which was proposed by the Surveyor. The Assistant Engineer had the plans also with him.

In the plans the length is shown as 4,200 ft., whereas in the printed Report 10,000 ft. is stated. The details of the sluice outlets and of the escapes are not drawn; if the line of canal was surveyed, it is not shown.

The plans may have been sufficient for the late State Engineer, with his local knowledge and experience, but is not sufficient for an inexperienced Assistant Engineer to work upon, nor is there any estimate to guide one.

The following points are noted:—

- (1.) The plans are incomplete.
- (2.) The ground on which it is proposed to put the escapes is not rock, though at the north end rock must be near, and if any heavy floods were to pass over these places the ground would in time cut back, and would entail precautions of stone pitching to protect the masonry.
- (3.) The remains of the old bund are about 700 ft. long on the north side of the nullah, and the top about 30 ft. above the bed of the stream, which is now (13th Jan.) flowing about 100 fathoms.
- (4.) The site of the proposed bund is in the Jagir of Muglana on the north end. Muglana is a kasba of Panchpahar.

- (5.) The surveys were made about 4 years ago. The Tehsildar, Gobind Lall, and Kanungo Bindraban at that time are said to have shown the place to the Surveyor, Altaf Hussain. The basin is a fine one, and the existing remains of the old bund may perhaps have influenced them, but the present village authorities and the Lumbardar, Madho Singh, state that in their opinion it will not be a profitable work, as there is little of Panchpahar or Khalsa land below. This requires to be ascertained by survey.
- (6.) When asked if this was pointed out to the State Engineer, when he came here and asked for the village authorities, they state they were not here.
- (7.) The line on which the bund was taken crosses a great deal of broken and low ground. It seems possible to avoid some of this by not going quite straight, and perhaps making two reservoirs, one on each drainage instead of one large reservoir. One or two trial lines would be required to settle this.
- (8.) It is not known whether any compensation would be necessary for any lands or wells submerged.
- (9.) The line for the canals would apparently have to cross a good deal of broken ground, and until they have been surveyed and laid out it is impossible to say what they would cost or how much Khalsa or other land would be irrigated. The water might be led out higher than these persons think.

Whenever Surveyors are available a revised plan and estimate might be prepared, but under present circumstances I do not recommend this project; the cost is great, and, considering the resources of the State, I think the money can be better laid out in other places, at present at all events.

The Lumbardar then took us to an earthen bund about 950 ft. long near and south of the village Panchpahar on the right bank of the nullah and near it—where a gap exists about 50 ft. in average width, and where the banks are about 25 ft. high—which, if required, he said would benefit the wells below. I am doubtful whether the nullah being so close would not carry off all the percolation, but it would cost little to close this gap and might do good. There is a little cultivation in the bed. It is a small work and could be easily carried out by the village authorities, care being taken to cut a trench in the gap at the bottom and sides to ensure the new earth and the old work being firmly united; also that there is the means of passing off any excess of water if the tank filled.

The average depth of water in the wells near is 30 ft. and the rock is met with about 20 ft. below the ground. It takes about two days, it is said, to water a bigha.

APPENDIX XIV.

GURARIA.

12th January 1904.

Started at 7-40 A.M. in tonga with Assistant Engineer, Abdur Rahman ; drove as far as Guraria, $4\frac{1}{2}$ miles. Here we were met by the Kanungo, Jai Behari Lall, the Patel, Inder Singh, and villagers. I explained my wish to see the place marked by Mr. Tickell on the map as a site for a bund, where two well-defined nullahs met about $\frac{1}{2}$ mile west of the village. They took me instead to a place about a mile south-west where a small bund might be made, but it was not the place I wished to see. It is called Barnali-ka-khera or Naka Sarna. There is a natural low range of high rocky ground running north and south which would form a natural bund, the gap to be banded up being about 500 ft. wide. There is a good basin inside and good land below.

Until it is surveyed it is impossible to say whether it will be found to be a good work to take up or not, but it is quite worth while to have plans and estimate prepared.

The next day (13th January) we went again to Guraria to see the place marked on the map, where two nullahs unite about half a mile west of the village. It did not commend itself as deserving of consideration, at present at all events.

A better place seems to be near the village to the east, where a low range forms a natural bund on the east, and all that would be necessary would be a bund across the water course to connect this range with high ground to the north-west. There appears to be any amount of good ground to the east of Guraria, a Khalsa village which could be irrigated. It is true the water will be impounded by the bund at Hathuain, but it is probable there is far more water than can be impounded.

The plans and estimates might be prepared, and if found to be as good a project as it appears to be, it could be carried out whenever funds are available and the Durbar desires.

APPENDIX XV.

MORIA.

We then proceeded towards Hathunia, but hearing in the course of conversation that there was a bund at *Moria*, a Khalsa village $1\frac{1}{2}$ mile further south, which had been breached, we rode there to see it. The masonry escape had been built by unprofessional agency, in black soil, without proper foundations or proper apron below, and had been completely breached, leaving a gap about 50 ft. wide through the earthen bund down to the natural ground level. This work had stood one rains, which were not enough to fill the tank, but even then the Kanungo says it benefited wells below

Last year it overflowed and was breached at the escape. It ought to be repaired at once, care being taken to dig well into the ground and both sides, so as to ensure the new earth being firmly united to the old work

Further south a few chains there appears to be a better place for an escape. The ground is covered with rocks, which should be levelled off for about 300 ft and examined to see if there is good rock ; if not, a low wall should be built, and outside, the surface of the ground should be protected with dry stone pitching let into the ground about 10 feet wide and two feet deep. The earth-work of the bund should be everywhere 5 ft. above the level of the escape. There is some cultivation in the bed now, but until the gap is closed the tank will hold no water. There is plenty of good land below.

We then rode through Lolra to Molra and on to the bund at Hathunia, $4\frac{1}{2}$ miles. Mr. Tickell had marked the site for a bund at Molra as No. 18 on the Topographical Map, but as the village is Jagir I purposely did not go to see the site, lest it should be misunderstood.

APPENDIX XVI.**RAMNAWAS GHATOD.**

On the 14th January 1904 we inspected two old tanks at the villages of Ramnawas Ghatod. The tanks at present are small and comparatively insignificant. A small nullah passes between them, the water of which goes to waste in the rains. In ordinary years the tanks are easily filled. The nullah might be easily bunded up and both the tanks repaired, enlarged and their value increased. The representatives of the villages met us at the site to show us what they proposed. There is plenty of good land below. A plan was shown to us which was made many years ago, but appears to be incomplete.

One of the villages is Khalsa, the other belongs to the Maharanee, and it is not known whether any action is desired.

If the Durbar wishes anything to be done, plans and estimates should be prepared to determine what is possible and what it would cost.

APPENDIX XVII.

SHAMIA.

At *Shamia*, a village belonging to the Raj Rana, the Kamdar. Govind Lall, who came with us from Ghotad, asked advice about making a tank to store the water of a nullah which passes near the village on the east side. His idea was to dam up the nullah low down before it joined the River Rewa, and he took us to this place.

The disadvantages of such a place are, that the bund would be in rich cultivated land, which would suffer; that any percolation of water stored by the bund would do no good to the village wells above it, but would to a certainty pass away into the river as the lowest place.

All this was explained to him, and it was suggested that the old village tank above the village and close to it should be repaired instead. A good bank exists for several hundred feet, and by connecting it with the high ground westward, between Shamia and Khod, it seems possible to make a very fine tank here.

It would store the water of this nullah which all goes to waste now, and any percolation from it would benefit the wells below, besides affording a plentiful supply to the village. It would also be taking advantage of all the earth-work in the old bund, which would save some expense.

I would suggest plans and estimate be prepared accordingly. If a bund is made as suggested, it will be advisable to make it clear of any of the old trees in the old bund line, as the roots of any large trees in an earthen bund sometimes allow a passage for water and are always a source of danger.

APPENDIX XVIII.

DEORI.

We then rode to Deori about $1\frac{1}{4}$ mile south of Panchpahar. There is any amount of good black soil in this direction, and the Khalsa villages of Deori, Mandwi, Khundikhera, Lasuria, Jhikria, Moskhera, Hathunia, Harmalia and Guraria, and the Jagir villages of Basnia, Gurari, Kethakhera, Kotra and Kharpa.

The Patels of Deori, Gulab Singh and Watandar, state that in the late famine they severely suffered; and this appears to be the case in every village about here.

The object of our visit was to see if it was possible to bund up and divert the small nullahs which unite on the west above the village of Deori, divert the water by a cut, and store it in long shallow tanks above each of the Khalsa villages.

Before we had time fully to explain our object the villagers themselves suggested this, and at once took us to the place where they stated something of this sort might be done. The drainage area certainly is not large, only about 2 square miles, but at present the water all runs to waste.

After going eastward about a mile we came to a shallow cut clearly-defined water course, by which the surface drainage joins a nullah above Mandwi.

If a shallow bank is made across the depression, say about a mile long, at such a point below the Deori Nullah diversion as will admit of it being filled 8 or 10 ft deep, there is not the slightest doubt it would pay well. A long shallow tank here would catch its own surface drainage and would be filled by the diversion cut; as the water was let out on to the good Khalsa land below, the level ground round the margin of the bed could be cultivated and probably the whole bed would be utilised.

If it was found advisable the capacity of the tank could be increased at any time, or the diversion cut could be extended; if more water came than could be stored, a similar tank could be made on the next water course for the land of Lasuria, and so on for every Khalsa village, the overflow of one tank being diverted to the next below it. Such a system of small tanks does not commit the Durbar to any large initial expenditure, one might be tried first as an experiment and the process repeated as found desirable; each would be sufficient perhaps to supply all the present needs of every village. The work is of such a simple nature that after the proper levels have been given by a Surveyor and profiles set up, the work could be carried out by the village authorities.

The cost of such a work, say for a bank 12 ft high to contain 8 ft depth of water, would be approximately Rs. 5,000 a mile. Rs. 50,000 spent in this way above 10 villages would do great good, and in about 10 years every rupee would be repaid. As far as I have been able to ascertain the proposal meets the approval of the local authorities and the villagers

It may be urged that these tanks would be of no use in a famine year. It is true that the same quantity of water would not be received, but every nullah runs for few hours even in the worst year, and half a loaf is better than no bread. It may be noted that every drop of the surface drainage above these several tanks is caught, and it may perhaps be possible to divert water above Ratanpura to increase the supply to the Deori Nullah.

The diagram given herewith will help to illustrate the procedure suggested. It will be seen the Deori Nullah is diverted with the hope that it may be led to fill tanks at A. above Mandwi, B above Kundikhera and Lasuria, C. and D. above Moakhera and E. above Kotra and Jhikeria, all Khalsa villages.

Until levels have been taken and proper surveys made it is impossible to speak with certainty, but the ground all slopes eastward, and the above will be sufficient to illustrate the idea. It is a system which can be adopted in many places; and where the resources of a State are limited, and it is desired to spread the benefit of irrigation over a large area and to secure quick returns, it is better, perhaps, than attempting large storage reservoirs, which entail great outlay, in one locality, require good professional supervision and would take time to pay, and which, if *not a success*, might only throw back irrigation. Large storage reservoirs, if properly carried out are undoubtedly of great benefit, and when the State is in a position to take them up, it is to be hoped they may be carried out; but at present, under existing circumstances, I am disposed to consider the other to be the wiser and safer course.

But until there is a liberal expenditure on irrigation and a real interest shown in the subject, it cannot be expected that any real benefit will be apparent.

APPENDIX XIX.

Duragpura.—This is described in the printed Report as a very useful little tank, but owing to its small drainage area it does not always fill. Its catchment area is given as two sq. miles, its capacity as 50 m.c.ft. It is a masonry bund backed with earth; is said to have cost Rs 32,000; the average irrigated area to be 1,234 bighas and the average annual return as Rs. 4,617, which represents a return of 14 per cent. It irrigates fine rich land of one village below.

The villagers met us on the bund and complained of the leakage. It is difficult to say whether this is through the face wall, or under it, or both; but the ground below was a good deal water-logged, and the question is how to deal with it. Owing to the uncertainty of where the leakage occurs it does not seem advisable to spend money on any attempt to stop it, but if a drain is cut at the lowest part and cross cuts made to it from the ground which is water-logged, all the leakage might be led away to lower ground beyond, and there be utilised in irrigation by lift, if not by flow. This was explained to the Assistant Engineer and to the villagers, and it only remains to give it a trial.

APPENDIX XX.

Saranga Kheri.—The project is marked No. 1 in the printed Report, Appendix E, and is described as follows :—

“ A fine site for a tank to irrigate four villages, catchment area 12 sq. miles, capacity of tank 150 m.c. ft. percentage of a 30" rainfall required to fill the tank 18; earthen bund 6,000 ft. long; estimated cost Rs. 45,000; estimated irrigated area 2,700 bighas; estimated revenue Rs. 5,400, which represents a return of 12 per cent” The data on which these figures are calculated is not forthcoming. The site for the bund is a good one, there being rock in the bed and apparently good rocky ridges at each end for escapes. The basin is somewhat contracted, but it will contain a large body of water, and it does not appear there would be any valuable land submerged. There appears to be any amount of good land below, which could be irrigated. The ground is stony at the site and there appears to be a limited supply of earth near, so I think it would be better to have a masonry face-wall backed with earth, in preference to a bund entirely of earth, as suggested in the printed Report. The masonry should be well stopped into the rock. This appears to have been the opinion of the late Mr. Miles, also plans and estimates prepared in his time are ready, but as these were prepared more with reference to a supply of water to the Capital, it might be advisable to modify these to some extent and to consider the project now simply as an Irrigation Work.

The estimated cost as a water-supply scheme, including conduit pipes, service reservoirs, filters, &c., came to about 5½ lakhs, and this is probably far more than the Durbar would care to spend on any water-supply scheme. Even if the necessity was as urgent as it then seemed to be, at present the wells appear to be fairly well supplied, owing, perhaps, to the percolation from tanks near, which have been constructed since then.

Taking the average of 13 years' rainfall as 36.75 and the drainage area as 11 sq. miles the probable run-off is calculated as 379 m.c.ft., so that there is plenty of water available.

For the sake of economy the bund might be made at first of a reduced height—high enough to utilise the natural waste weirs at each, and it could be raised afterwards when the demand for the water increased. The masonry should in this case be of such a section below as would admit of this being done. I would suggest revised plans and estimates being prepared accordingly.

If the work is economically and properly carried out, it should prove a very good irrigation project.

PROTECTIVE IRRIGATION WORKS,
RAJPUTANA.

INSPECTION NOTE

ON

IRRIGATION WORKS AND PROJECTS,
HALAWAR STATE.

by
2 Supdg Engineer P. J. W. Raj:

1905.

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MAP OF JHALAWAR STATE, 4 miles = 1 inch,
showing all Projects and Sites referred to in Report.

INSPECTION NOTE ON IRRIGATION WORKS AND PROJECTS, JHALAWAR STATE.

Mr. Lakshmi Datt, Assistant Engineer-in-charge of the State Public Works Department, joined his appointment in April 1904. His establishment at present consists of:—

P. W. D.
Establish-
ment.

Sub-overseer Bindra Bau : Sub-overseer Mumtaz Ali : Moharrir
Rameshwar Pershad : and 2 Clerks, 1 Munshi, 1 Cashier,
1 Draftsman.

2. This year's budget is sanctioned for Rs. 40,000, of which Rs. 25,000 is for Irrigation, viz., Rs. 5,000 for repairs, Rs. 20,000 for new works.

Budget
Grant.

3. The Irrigation Works inspected, and new projects and sites visited are noted below:—

Inspected on 1st February 1905. Work was in progress on the Irrigation ducts; without these no advantage is possible from the Tank. (See Appendix IX, Report by Colonel Sir S. Jacob, Consulting Engineer for Irrigation in Rajputana). An Estimate for Rs. 700 has been sanctioned for their construction.

Stratton
Sagar
(Site No 1)

On right duct 35 chains have been partly excavated, and 17 chains remain to be done. 78 bighas of land have been irrigated this year, and 25 bighas more will be commanded when the work is finished.

On left duct 85 chains have been partly excavated, and 15 chains more can be done later; 800 bighas are commanded, but there are no cultivators available, and only 12 bighas have so far been taken up, and this by the State.

4. Inspected on 1st February 1905. (See Appendix V, Consulting Engineer's Report).

Nawa
Talao.
(Site No 2)

This is an old tank, but leaks badly, owing to the nature of the rock on which it was built. About 10 bighas are irrigated below from the leakage, and Khan Sahib Sheikh Subhan, who accompanied me, is anxious for a weir to be built across a nullah below to raise the water level, so that the leakage water may pass over a ridge to irrigate a little more land. He also showed me a site above the Talao near the Bhagan enclosure, where he suggested a dam being made, as the weir of the Nawa Talao overflows for days each rains.

The dam would not cost much, as it is a small gap. A masonry core-wall with earth in front and rear would be necessary, and the surplus water would spill over the rocky ridge on either side into the Nawa Talao. There is no land below, and the bed of the new tank formed is rocky and

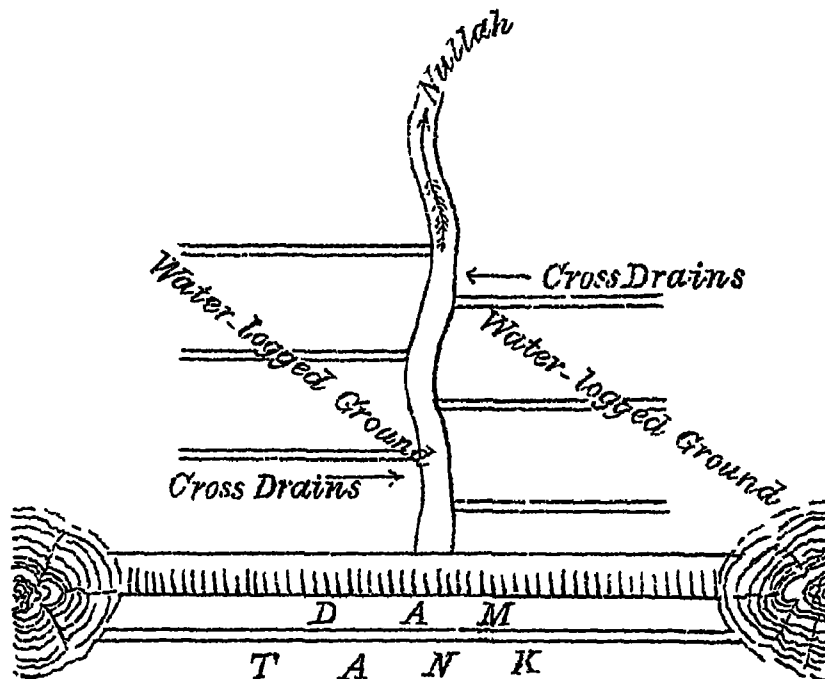
unculturable, so that it would simply form an addition to the city water supply.

I would not therefore recommend spending money on these proposals at present, as it is more urgently required, and can be expended with greater advantage elsewhere in the State.

Duragpura.
(Site No. 3.)

5. Inspected on 2nd February 1905. (See Appendix XIX, Consulting Engineer's Report). The cross cuts suggested by the Consulting Engineer have not been made, but the nullah below the dam into which the leakage flows has been bunded up lower down and diverted into the fields for Irrigation, and the Assistant Engineer informs me that 78 bighas have been irrigated in this way.

During the next hot weather, these cross cuts from the water-logged ground on either side the Nullah should be made as per sketch.



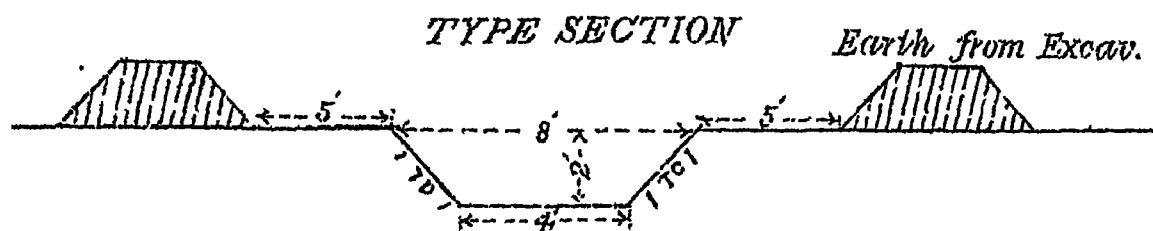
Kishanpura
(Site No. 4.)

6. Inspected on 2nd February 1905. (See Appendix X, Consulting Engineer's Report).

The Irrigation channels are in progress, and an estimate for Rs. 900 has been sanctioned for their construction.

On the right bank 111 chains out of the 130 chains estimated for and set out have been partly excavated; and on the left bank 17 chains in extension of the 30 chains originally executed when the tank was constructed. In excavating the channels vertical sides have been given to save expense, and the earth excavated has been thrown up anyhow on either edge, even on sloping ground. This is a mistake, as in black soil the vertical sides will give way, and the earth on the edges is liable to fall in at any time. Except in rock and hard morrum, a slope of 1 to 1 should be given to the sides when constructing the channels, templates being constructed of the section of channel as a guide to the mates in charge.

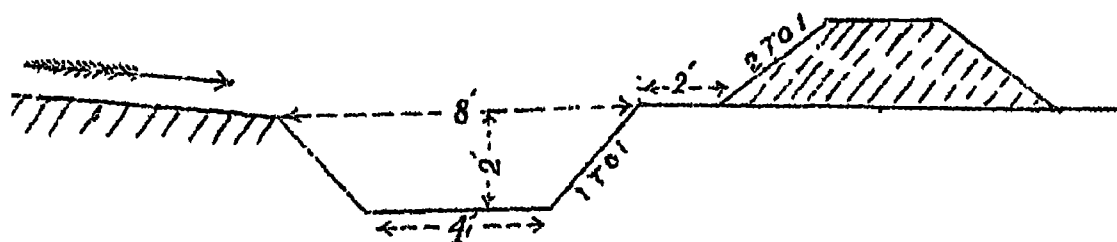
On level ground, a berm of *at least* 5 ft. on either side should be given, and the earth excavated formed into a bank of proper section.



It will be found more economical to do this at once, will save any chance of sides and earth excavated falling back into the channel, and the channel can also be widened later if found necessary.

On side-long ground the earth excavated should be formed into a bank on the *lower side only*; and any surface drainage in the rains will then pass away down the channel.

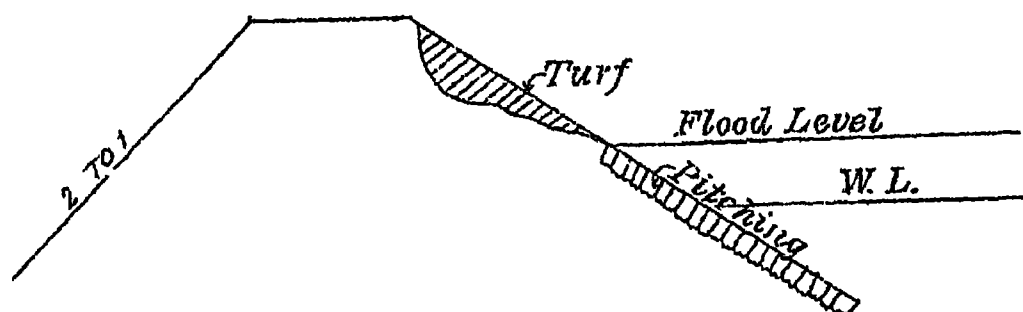
The earth which has now been thrown up above the channel should be removed, otherwise in the rains it will all be washed back into the channel again, and cause trouble.



The apron below weir recommended by Consulting Engineer has been made, but later on, when there are funds, I would recommend the weir being placed at the south-east end by the Kishonpura Village, where there is rocky high ground, and the water would spill over this without doing harm, into the nullah below.

The dam would be extended on the north-west beyond the present weir till high ground is reached. At present the flood water damages the fields below at this end, and if the weir was altered I understand 25 bighas extra could be irrigated.

The front slope of dam, especially at south east end, wants making up, as it is cut up by waves, etc.; and it should be turfed down to flood level and pitched below, to prevent a recurrence of this.



Pitching is also required on the north-west side of sluice.

Increasing
Catchment
of Gaonri
Tank.
(Site No. 5.)

7. The Diwan Sahib spoke to me about the possibility of further increasing the catchment of the Gaonri Tank

In Appendix III of Consulting Engineer's Report it is stated, "the tank usually does not more than half fill, owing to its very small catchment ($1\frac{3}{4}$ square miles); a rainfall of 40 inches or more will fill it." In Mr. Tickell's time feeders were constructed along the foot of the hills, both from the south-west and north-east, and apparently Rs. 3,678 (Appendix VII) was spent on this.

The north-east feeder cuts off a portion of the Kishenpura and Dunga-pura tanks' catchment, and nothing more can be done without further injury to these and the Stratton Sagar, unless, as suggested by the Assistant Engineer, similar feeders were made on the south side of the range of hills, and taken by a cut through the gap in the hill by Raipura. But this would be expensive, and as the Gaonri is only used for irrigating a few gardens, it would not, it is thought, be wise to do any thing further likely to damage the three tanks named above, which command good irrigable land, or to spend money on the Gaonri, till other tanks of more importance in other parts of the State are carried out.

Mandli-
akheri
(Site No 6)

8. On 3rd February went along the line of the Left Irrigation Duct beyond the Stratton Sagar, up to Mandliakheri Tank. (See Appendix VIII, Consulting Engineer's Report).

The Left Irrigation Channel starts about 20 ch. above the road dam on Asnawar Road (para. 9, Appendix VIII), just below Chandrawati Temple, where a weir has been built on sound rock. The channel has 5 ft. bed width and 2 ft. depth, and is nearly all in excavation. It has been excavated for 3 miles, turning to the north-west along the foot of the hills on which the fort is situated, below Gandher village, and has been surveyed for $1\frac{1}{2}$ miles more. When completed it will have a total length of $4\frac{1}{2}$ miles, and will command all the land between the hills and the Kali Sindh River, up to the point where the Stratton Sagar River duct comes into play.

A revised Estimate for Rs. 1,800 has been submitted for this duct and Rs. 1,300 spent to date.

The Right duct has also been partly excavated for 2 miles up to the Jaoria Nullah, and surveyed for $4\frac{1}{2}$ miles further on; when completed it will have a total length of $6\frac{1}{2}$ miles, and will command 5,000 bighas.

The same rules for carrying out the work, noted in para 6 above should be followed, as the same mistakes have been made; and as the excavation is still in progress the necessary alterations should be carried out at once.

Dam.—The points noted by the Consulting Engineer in Paras. (1), (2), (3), (4), (5), (6), and (7) of Appendix VIII, have been carried out or are in progress.

With regard to para. (8) the flood water has cut away the surface earth at the south weir down to rock, lowering the weir level to nearly 5 ft.

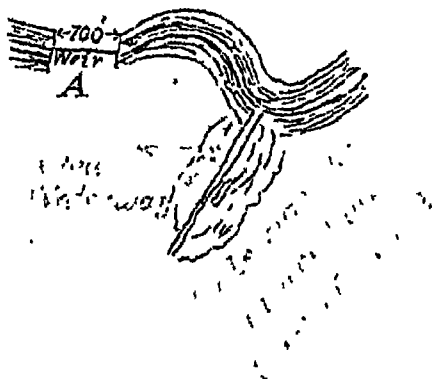
The water is cutting away the toe of the rear slope of the dam and a large area of good culturable land, in finding its way down to the nullah.

The Assistant Engineer proposes continuing the dam at this end on to high ground, and closing this weir altogether.

The north weir is 700 ft. in length, and forms the weir of the combined Mandliakhera and Patan tanks. The catchment area of the two is $7 + 18 = 25$ square miles, and the maximum discharge on this (by Dicken's Formula) 9,223.5 cusecs.

A weir 700 ft. long will discharge this with a $2\frac{1}{2}$ -ft. head.

If the south weir is closed altogether—and I think it certainly should be done—levels must be taken to see that the ridge dividing the two catchments of the Mandliakheri tank is not higher than crest of the north weir. If it is, the ridge must be cut down to this level for 700 ft. in



length, to give a clear water passage for the flood water to the weir, otherwise the water will head up and there will be danger to the dam.

9. There is an old Masonry Irrigation Duct from the Patan tank. This has a section of 2 square ft., and is $2\frac{1}{2}$ miles long, ending on the north of the Fort Hill, before Ghandan village is reached.

Patan Tank
(Site No. 7.)

The Assistant Engineer has made surveys for extending this 50 chains, to command 300 bighas above the Mandliakheri Duct.

If there are cultivators to take up the land this extension should be carried out, as at present only 264 bighas are irrigated from the Patan tank. (See Appendix IV, Consulting Engineer's Report).

10. Inspected on 4th February 1905 (See Appendix XX, Consulting Engineer's Report).

Sarangakheri Tank
(Site No. 8.)

The site shown us, and the villagers said it was the same as shown to the Consulting Engineer, is about $\frac{1}{4}$ of a mile south of Sarangakheri village, where the river runs through high rocky ridges. There is rock in the river bed, and low hills of boulders of trap on either side, about 900 ft. apart. The basin is contracted, but all waste land; and there is good and below.

If a dam is built here, a masonry face-wall will be necessary, as earth is scarce; and levels should be taken back from the land on the north of

the village to fix approximately sill level of sluice; and the weir level might be made 7 ft. higher than this, and the crest of dam 5 ft. above this again.

This site does not appear to correspond with the plans for the storage reservoirs proposed by Mr. Miles for the water supply of Patan city and Chaoni. There were no prismatic surveys taken and no permanent bench marks left to show the site; but the dam was 3400 ft. long, and the report of the water-works project says the site was $1\frac{1}{2}$ miles above Sarangakheri village.

Moharrir Rameshwar Pershad, who was sent by the Assistant Engineer to fix the line of dam, from the bearings and length laid out the site about a mile below Sarangakheri village, between Mangal village on the left and Jarer village on the right bank.

This site was inspected, and a little above the line fixed by the Moharrir there is a splendid site (Site No. 9) for constructing a storage reservoir for Irrigation. There is a grand basin, all of black soil, at present uncultivated, which would produce wheat as the water of the reservoir receded; there is good earth all along for the dam, and any quantity of land below for irrigation, stretching away between Kishen-pura and Chandiakheri on the right and from Mangal towards Patan city on the left bank.

The catchment area is $16\frac{3}{4}$ square miles, and allowing 10 per cent. of the average rainfall of 30 inches, 117 m.c.ft. of water should be available for storage sufficient for 1170 acres.

The dam would start from a babul tree at the south corner of Jarer village on the right bank, across to a tika tree on the left, and on to the ridge till the necessary level for crest of dam was reached.

The weir would be on the right bank on the high ground by Jarer village. The right bank of the nullah is high and perpendicular; on the left the ground slopes away gradually. A core-wall would be advisable across the nullah portion, but the rest of the dam would be entirely of earth, black soil similar to the Mandliakheri tank.

The dam would be about 1 mile long, and taking the Mandliakheri dam as a guide, would cost about Rs. 50,000.

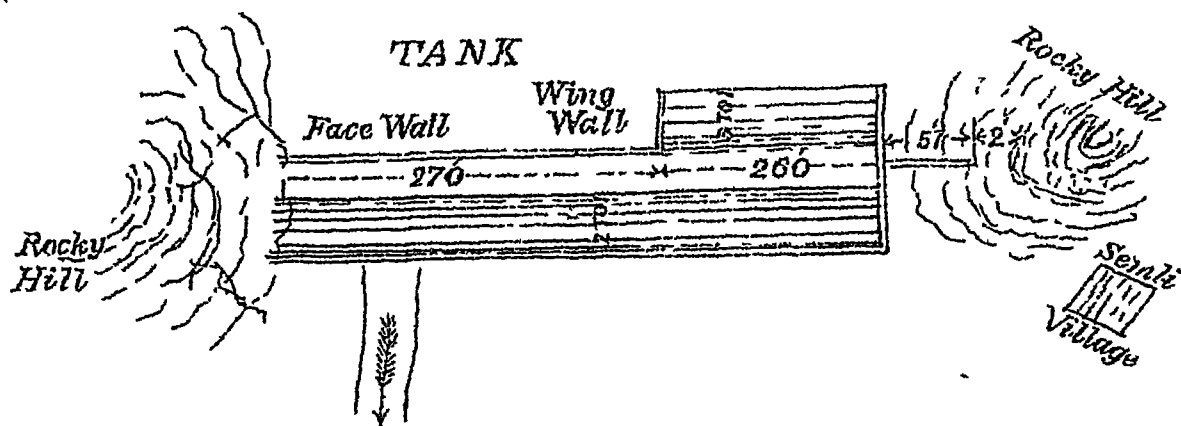
This is a most promising project, and if funds were available, and also sufficient cultivators, should be carried out without delay. Surveys should certainly be made and the project worked out, and the Assistant Engineer informs me that he will have this done under his own directions.

Small Tank
(Site No. 10.)

11. This small tank was built in 1878 by Mr. Miles.

The total length of dam is 530 ft., with a weir 78 ft. in length at north end, near the village. At the south end where it crosses the nullah, the dam has a masonry face-wall 270 ft. in length, backed with earth, and for

the remaining 260 ft. up to the weir is entirely of earth-work. On the dam there are now a large number of babul trees.



There is no sluice, the water is lifted by charas for Irrigation and six are at work.

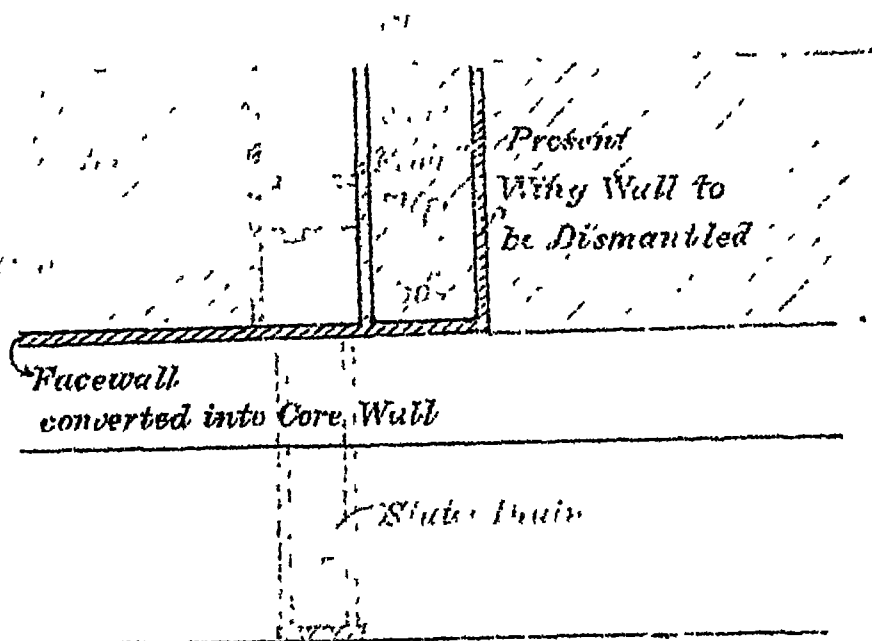
The tank has a catchment of 1 square mile, all hilly; capacity of 1.98 m. c.ft.; and about 40 bighas are irrigated. The villagers are most anxious for the weir and dam to be raised, as it overflows every year and there is plenty of land available for irrigation below.

With the hilly small catchment 20 per cent. of the average rainfall of 30 inches should certainly be available for storage, or 13 m.c.ft., sufficient for 130 acres or 325 bighas.

It would therefore seem well worth raising the weir and dam and building a sluice.

The Assistant Engineer should check the present capacity, and take contours of the basin to find the height the weir should be raised to give the proposed capacity. The maximum flood on 1 square mile is 825 cusecs, and this can be discharged by the 78 ft. weir with 2-ft. head, so crest of dam should be made 5 ft. above now weir level.

The babul trees should be removed and sold, and all roots removed before adding the new earth; and the face-wall might be converted into a core-wall, and to prevent any chance of water creeping round, the sluice should be fixed 10 ft. from the wing-wall, which should be dismantled as it is all cracked. The sketch shows what is suggested.



Motipura.
(Site No. 11.)

12. The site for this small project, which has been worked out by the Assistant Engineer, was inspected on the morning of 5th February. This is one of the Irrigation Works proposed by Mr. Tickell in Appendix E of his Report.

The site is just above the villages of Motipura (Khalsa) on the right bank and Samrai (Jagir) on the left.

The basin is very flat, entailing a long bund and little storage, the greatest depth being 9 ft., so a shallow tank will be formed. The following are the details taken from the Report of Estimate :—

Earthen Dam	...	...	...	4,200 ft. long.
Weir	...	...	...	300 ft. long.
at east end on right bank of nullah.				
Catchment Area	...	...	...	6 sq. miles.
Capacity	...	...	...	28.48 m.c.ft.
Available for Irrigation	...	...	...	27.43 "
Area available for Irrigation	...	...	...	600 bighas.
Cost of Project	...	...	...	Rs. 9,520

Probable Revenue @ 2 rupees per bigha = 1,200 rupees, or nearly 13 per cent. profit.

This is irrespective of the bed, about 200 acres, which is at present uncultivated and could all be sown with wheat as the water recedes. The value of water stored is 2,989 c.ft. per rupee, so it is a cheap project and should certainly be carried out, as in addition to the extra land brought under cultivation the wells will be benefitted. Of the 40 wells in Motipura I was informed that only 25 are now in use, for want of water.

Before starting the work, the following corrections appear necessary :—

From topographical Survey the catchment is 7.5 square miles; from this the maximum discharge (Dickens Formula) is 3,737 cusecs, and the length of weir required to discharge this with 2-ft. head is 375 ft.

The dam is proposed to be 6 ft. wide at top, with front slope $2\frac{1}{2}$ to 1 and rear slope 2 to 1. Crest 5 ft. above weir level. The front slope should be made 3 to 1. The size of Sluice and Irrigation Channel required is not given, these should be worked out always by—

- (a) Finding the discharge per second required to empty the tank in four months (Rabi Irrigation season);
- (b) And as water is required simultaneously at first for Irrigation, the discharge required per second to give a first watering of 6 inches in 30 days of 12 hour flow to the whole area for which there is sufficient water.

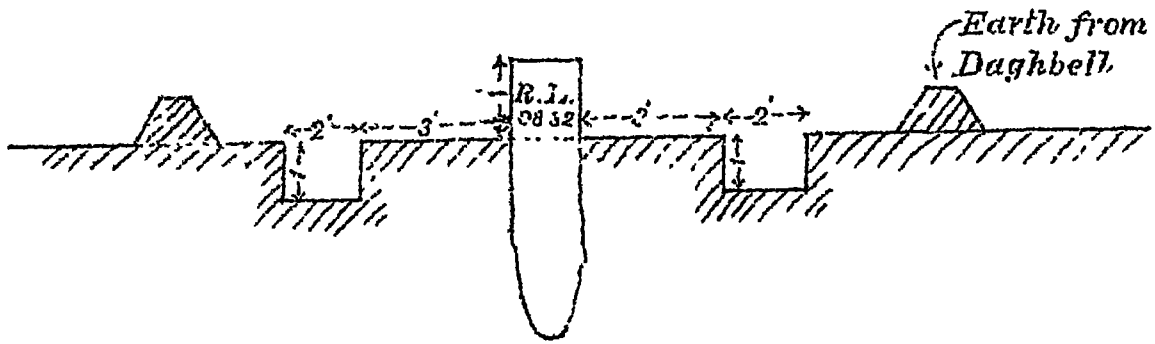
This has been explained in detail to the Assistant Engineer.

The line of the proposed dam was not daghbelled out, nor were there any permanent bench marks. Wherever

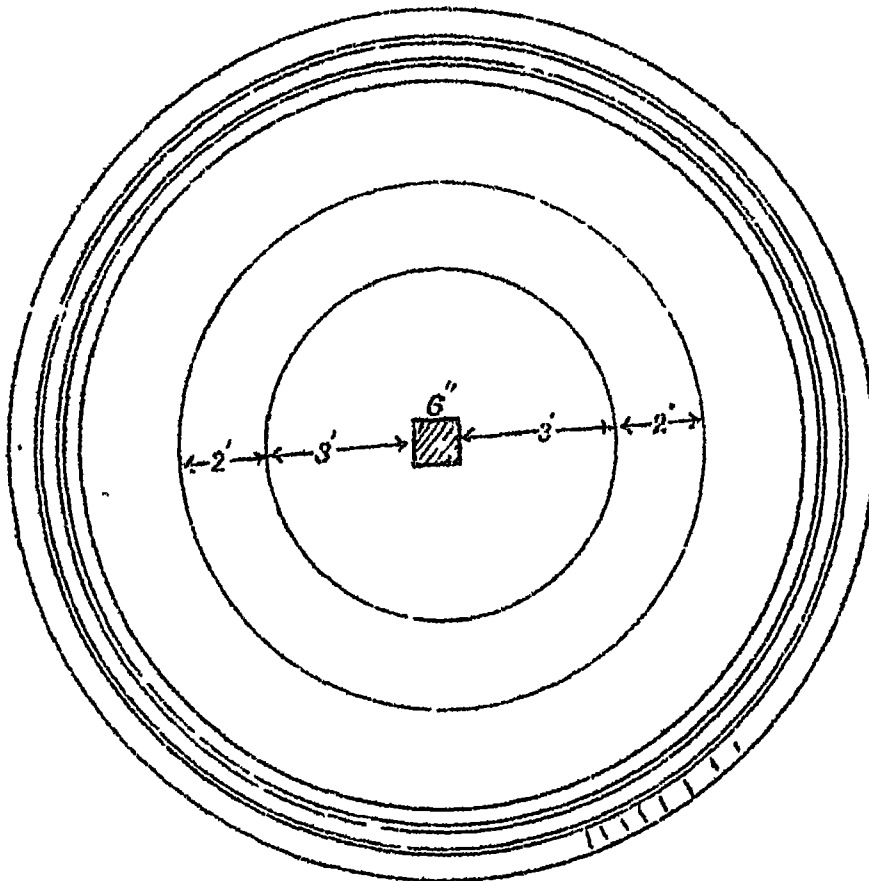
projects are surveyed, for check and future reference, the Assistant Engineer should arrange always to have :—

- (a) The line of dam clearly daghbelled from end to end, 1 ft. wide and 1 ft. deep.
- (b) Permanent bench marks erected, cut out of the rock in river beds or where rock occurs, along the line of dam, showing the bed level of nullah, and every 5 ft. rise, also at any point where the line changes. Also at ends of the base line and cross-section lines of survey.

These bench marks should be stones set on edge, imbedded $1\frac{1}{2}$ in the ground, with a circular daghbell all round as per sketch, the number and reduced level, corresponding with Field Book, being marked on the stone.



SECTION



PLAN

If this was done there would be no difficulty in finding the sites, check-

ing the work, and setting it out whenever it was decided to take it up, even should this be a year or two after the surveys were made.

Shamia
(Site No 12).

13. Inspected on 5th February (See Appendix XVII of Consulting Engineer's Report).

This is a Jagir village, belonging to the Maharani Rahtoriji; and I was accompanied by the Kamdar Raja Ram and Patwari. In accordance with the Consulting Engineer's suggestions, surveys will be made by Surveyor Overseer Mannu Lal to enable plans and estimates for restoring and enlarging the old dam just above the village. The breached portion across the nullah will be closed by a strong earthen dam, well trenched into the bed, and sides of the nullah and existing dam; and the old surface for the entire length must be dug up, and all grass, roots and bushes removed before new earth is commenced.

The weir will be at the north end, where the water will spill down to the Rewa naddi.

The catchment area is 3.75 square miles, so that allowing 10 per cent. of average rainfall of 30 inches we can count on storing 26 m.c.ft. sufficient for 260 acres, more than the existing land, but the excess water will be useful for the village and cattle.

Rewa River
Project
(Site No 13)

14. From Shamia the sites suggested by the Consulting Engineer (Appendix XII) at Khod and Imliakheri for the Rewa River project were inspected.

This is a very large project, and it is doubtful whether it will be worth working out in detail, but orders for preliminary surveys to give sufficient data to enable a decision to be made have been ordered, and will be carried out by Surveyor Mannu Lal. The best site, it is thought, for the dam will be starting from high ground south of Panchakheri village on the left bank, across the river just south of Khod, where the line would turn to the south-east till high ground is reached.

The catchment area at the site is 136 square miles, and allowing 10 per cent of the average rainfall of 30 inches this would give 952 m. c.ft. of water for storage, sufficient for 9,500 acres, if all could be used. The river is about 150 ft. broad, and the banks 20 ft. high, and the land to be irrigated is high, so a great portion of the water stored in the river bed will, it is feared, not be available for irrigation. Imliakheri is a deserted village, but Kharanpura (K) village, south-east of Panchakheri, which contains about ten houses, would probably be submerged.

As it will probably be necessary to enter Indore and Gwalior territory to make the preliminary surveys to see how far the water will spread back, the Residents of these States have been addressed, and sanction for this asked for.

Ramnawaz
Ghatod
(Site No 14)

15. Inspected on 6th February (See Appendix XVI, Consulting Engineer's Report).

The Kamdar Raja Ram and the Patwari met me at these villages.

As pointed out by the Consulting Engineer the only useful thing to be done is to bund up the nullah, which at present passes between the two tanks, and form one tank; enlarging and repairing the existing dams. The level of the Panchpahar road, which runs along the south-east of the Ramnawas tank, will fix the flood level. The combined catchment is 1 square mile, so 7 m. c. ft. will be available for storage. The representatives of the two villages and tanks want each tank kept separate, but this is not possible if the water of the nullah is to be made use of. When one tank is formed the Ghatod (Jagir) land will obtain the greatest benefit as this tank is at a lower-level; as they have the larger area of land to irrigate this is as it should be. Both parties wished for surveys to be made and Plans and Estimate for the combined tank prepared, so directions were given for this to Overseer Mannu Lal; and it is hoped that some agreement will be arrived at for the execution of the work, as it is a great pity to lose water when land is lying idle for want of it.

16. The site of the old bund was inspected on 7th February, with the rough Plans prepared by Mr. Tickell (See Appendix XIII, Consulting Engineer's Report). This project is not approved by the local authorities, and this is satisfactory, as the new railway (Nagda-Muttra) line passes through the bed of the tank, and there will be a Railway bridge across the nullah just below the dam.

Panch-
pahar
Tank.
(Site No. 15).

17. About 4 miles east of Panchpahar a very good site (Site No. 16) for constructing a large storage reservoir and making use of this water was found at the junction of the Panchpahar and Ramti nullahs at Gangpura. The catchment area at this point is 48 square miles, which should allow 336 m. c. ft. of water to be stored, sufficient for 3,350 acres. There is a good basin, and the Irrigation Canal on the right bank could be taken on the water shed from Lasaria to Jhikria; and all the land down to the border, the bank of the Au river, could be irrigated. On the left the land between Sulia and Senli would be commanded.

Gangpura
Kundik-
hera
Project
(Site No. 16).

The dam would start from high ground east of Kundikhera, and between that village and Lasaria; cross the river just below Ganjpura, and on to the high ground on the left bank near the Panchpahar road. Ganjpura would be submerged, but there are only 15 houses now occupied since the famine, and about 50 inhabitants, and at little cost it could be removed to higher ground.

This is a large project, and not likely to be carried out till the finances of the State improve, and there are more cultivators available; but with the railway it is hoped great advantage will accrue, and in years to come all the water available will be made use of and all land taken up. Overseer Ram Chander has therefore been directed to prepare the necessary surveys and work out the project, which will be submitted in due course.

18. This was inspected on 8th February.

The work is simple, and the Consulting Engineer's directions in Appendix XVIII, with Plan to illustrate same, so clear, that the Assistant Engineer will have no difficulty in preparing the Project.

Deori
Feeder
Channel.
(Site No. 17).

Nothing has been done so far, but the Assistant Engineer should have the necessary levels taken and estimate prepared without delay. The line of feeder and dam for each storage reservoir should be dagh-belled, and permanent bench marks erected, so that the work can be carried out at any time.

Hatunia
(Site No. 18).

19. Inspected on 8th February. The Consulting Engineer has here also given clear directions in Appendix XI of what is required to enable revised Plans and Estimate to be prepared. The Assistant Engineer had not visited the site before; so we went over it together, with the Consulting Engineer's directions; and one of the State Surveyors will be put on to the work, and a revised estimate prepared; and the Durbar will then know what funds are required to finish the work.

The site is such a good one, and expenditure has already been incurred on the work, that there seems every reason for completing the project as soon as possible. The earth at the site is a mixture of black soil and morum, and seems to be excellent for dam construction, as there is not a crack to be seen in any of the work already carried out.

Ratanpura
(Site No. 19).

20. This is Project No. 8, Appendix E. in Mr. Tickell's Report. Ratanpura village is 3 miles south of Panchpahar, and there is an old dam, which has been lying breached for years. This was inspected with the Assistant Engineer on 9th February.

The nullah runs between a high hill on the left bank and a ridge on the right, starting from Ratanpura village, on which an earthen dam was constructed, the gap through which the nullah flows being dammed by a masonry wall about 200 ft. long, 10 ft. wide at top, and about 12 ft. above the nullah bed.

The water got round at the left bank, and the wall gave way, and is cracked at intervals, and the face masonry is out of repair; trees and bushes are growing out of it at the nullah edge. In the face-wall there are two very good carved images, taken from temples; these should be preserved.

The Assistant Engineer has had surveys made and a project for restoring the dam prepared; the following are the details given by him.

Catchment Area	...	...	...	2 square miles.
Capacity	...	...	...	22 m. c. ft.
Weir level	...	...	...	26 ft. above Nullah bed.
Top of Dam	...	...	...	31 ft. " " "
				i.e., 5 ft. above weir.

Weir, 200 ft. long on the ridge near Ratanpura village.

An earthen dam to be constructed in front of the breached masonry dam, 8 ft. top width, front slope 3 to 1, rear slope 2 to 1.

The ridge on right to be made up to proper levels by earthwork, 5 ft. top width, front slope 3 to 1, and rear slope 2 to 1.

Estimated cost Rs. 7,000.

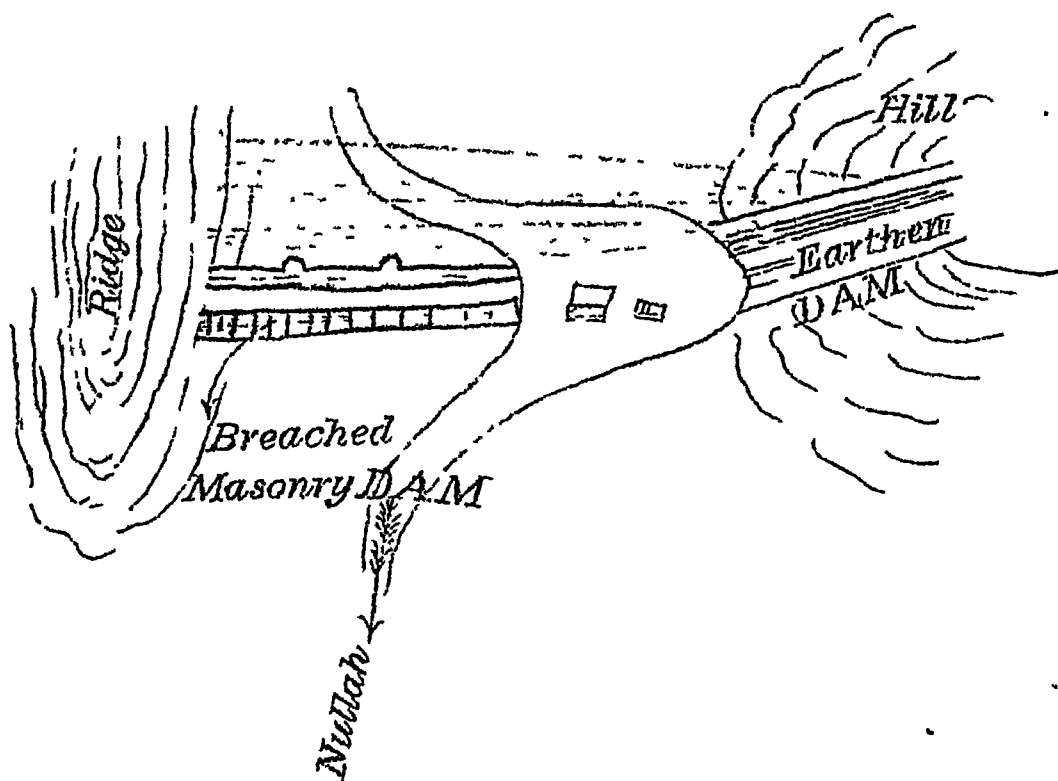
Value of water stored 3,143 c.ft. per rupee.

Revenue for 220 acres = 550 bighas @ Rs. 2 per bigha = Rs. 1,100 per annum or over 15 per cent. profit.

But the catchment area has been over estimated, as from the Topographical Survey Map it is only half a square mile.

This reduces the water available for storage to 7 m. c. ft. even if we allow 20 per cent. of rainfall, as the catchment is hilly. This will therefore reduce the capacity of the tank, and the surveys should be carefully checked and the water-spread and capacity at each 5 ft. contour carefully worked out.

The weir level should be kept at the lowest point of the ridge towards Ratanpura village, and the water allowed to spill over here, even should this give a greater capacity than required; the maximum discharge on the half square mile catchment is 490 cusecs, and as this gap in the ridge is about 400 ft. long the water is not likely to cut it away. The line proposed by the Assistant Engineer for the earthen dam across the nullah may be accepted, but care must be taken that the new dam is entirely separated from the old dam; and the space in rear between should be filled up to the top of the masonry wall to prevent a pool of water being held up between, which would damage the dam.



The line of dam was not daghballed out, nor were there any permanent bench marks, not even one on the masonry dam, so that it is impossible to check the surveys made by Sub-overseer Muntaz Ali. The directions given in para. 12 should always be carried out.

The Plans made are difficult to estimate from, as the cross sections are drawn to far too small a scale.

They should always be drawn to a natural scale 10 ft. = 1 inch. Directions on this point and a printed copy of one of the projects prepared in this office have been given to the Assistant Engineer as a guide for the future.

Also a copy of "Directions for Surveyors in preparing Irrigation Projects," as this may be useful.

Sarod
(Site No. 20).

21. Sarod is about 2 miles south-west of Ratanpura, and the villagers are very anxious for a dam to be constructed about 1 mile to west of village, where the nullah, which flows past the village itself, issues from the hills. The Assistant Engineer has had surveys made and the project is being prepared.

The site was inspected with him on the morning of 9th, and the Patel of the village accompanied us.

The details of the project as given by the Assistant Engineer are :—

Catchment Area ...	...	...	7½ square miles.
Capacity ...	...	...	50 m. c.ft.
Length of Dam ...	...	...	1,225 r.ft.
Weir level ...	...	...	29 ft. above nullah bed.
Crest of Dam ...	...	...	5 ft. above weir ; and 31 above nullah bed.

The line for dam selected by the Assistant Engineer ran just in front of a small tributary nullah from the hill on the right bank, and he proposed to have his weir at the south end at the foot of these hills, the flood water finding its way back to the main nullah by this tributary. It would be better to alter the line to include this nullah inside the basin of proposed tank, and have the weir at the north end, cut out as far as possible from the rocky hill on left bank of the main nullah which flows at the foot of this hill ; a core wall would be required in continuation of the weir for the portion of the dam across the nullah and for about 20 ft. into left bank.

The catchment area from topographical Map is only 1½ square miles, not 7½, so that not more than 17.5 m.c.ft. (20 per cent. of rainfall) can be expected for storage.

The survey should be checked, and the Plans and Estimate revised as above, the new line of dam being clearly daghbelled and permanent bench marks left.

Naka
Sarna
Guraria
(Site No. 21).

22. This site was inspected by the Consulting Engineer (and is described in Appendix XIV. of his Report). He considered "it was quite worth while to have Plans and Estimate prepared."

On the afternoon of 9th February we visited the site as well as the others noted by the Consulting Engineer at Guraria, and directions for the necessary surveys were given to Overseer Ram Chandar, who will prepare the Plans and Estimate in due course.

23. This small tank, described by the Consulting Engineer in Appendix XV., was visited on the morning of 10th. Moira
(Site No. 22).

An Estimate for carrying out the repairs recommended has been sanctioned, and the work has partly been carried out by the Assistant Engineer, but is now at a standstill for want of funds.

The breach at the site of the old weir has been closed, with an earthen dam pitched; the new weir, 200 ft. in length, has been constructed; and now 3 chains of earthen dam at the south end, by the weir, are required.

The top of dam at the sluice also wants making up to proper level, as it has sunk and cracked along the lines of the sluice drain below; the old surface should be well picked up and the cracks carefully filled and consolidated before the new earth is spread. The Assistant Engineer has built a toe-wall of masonry in lime at foot of rear slope, where the dam crosses the nullah. If a toe-wall was necessary it would have been better to build it of dry stone masonry with chips behind, to allow any leakage to pass through clear.

The ridge has also been cut away about a foot to make the weir; this was unnecessary, and reduces the possible capacity of the tank.

As there is a long, practically level, length of stony ridge at the south end, it would have been sufficient to clear this only, and not build any masonry wall for the weir till it was found that the surface cut away.

24. The Napania, Chandarpur and Harnia nullahs were investigated, but nothing is possible on these.

Nullahs
near Mis-
rauli and
Kantali
Nullah.

The Napania nullah flows through such a level plain that there are no sites for storage reservoirs, and the Chandarpura and Harnia nullahs are in such deep banks, with the land for irrigation high on either side, that if any dam was constructed the greater part of the storage would be in the river bed and unavailable for irrigation.

The Kantali nullah has a rocky bed, but only crosses a narrow strip of Jhalawar before it flows into the Au river on the east border, so that it would not pay to carry out anything on so large a river, even if a site was discovered, with so little land commanded.

25. On 11th, with the Assistant Engineer, inspected the Bani nullahs, with which it is feared nothing can be done, as though on the left bank the land slopes down from the Zalimpura Hill to the nullah, on the right bank it is very level, and if a dam was constructed round towards the Temple Hill behind and south of Bani, the village well lands would be submerged.

Nullahs
near Kara-
wan, Bani
Nullahs.

Gugwa
Tank
Project
(Site No. 23).

At Gugwa there is a site for a small tank, which His Highness the Raj Rana suggested for inspection. The line was shown to Sub-overseer Pars Ram, who will make the necessary surveys; the catchment area is only half a square mile, so if 20 per cent. of the average rainfall is stored, only 7 m. c. ft. is available, sufficient for 70 acres = 175 bighas. There are about 200 bighas of land commanded available for irrigation—100 belonging to Gugwa and 100 to Bara Khokria.

Singpura
Tank
Site No. 24).

From Gugwa we went to Singpura and on to a dam about 1 mile to west of the village which was constructed in 1901-1902 by the Tehsildar from plans prepared by Mr. Abdur Rahman, Assistant Engineer.

Mr. Tickell, in Appendix E of his Report, suggests a tank at Singpura, but his description does not agree with the one constructed. The dam is 900 ft. long, closing a gap between low hills, and the weir is over a ridge to the north of the hill at the north-end. Top width of dam is 8 ft.; front slope supposed to be 3 to 1, but appears steeper, and has sunk for the portion of dam across the nullah itself, where it is 35 ft. high. This front slope is pitched up to the top. Rear slope is 2 to 1. A masonry sluice well and drain under the dam has been constructed, but no irrigation channels, so at present no irrigation can be carried out from the tank. The sluice leaks badly, and the outlet chamber at toe of rear slope was filled with earth to reduce this leakage.

The dam is said to have cost Rs. 8,000, and the wells have been benefitted by its construction.

The water level has never risen higher than 10 ft. below crest of dam, and never nearly reached the weir level; there is no mention in Plans and Estimate shown me of the capacity of the tank, but as the catchment area is only .62 of a square mile, the most that can be calculated on for storage is $8\frac{1}{2}$ m. c. ft. of water.

The Assistant Engineer should check the capacity of the tank, and prepare an Estimate for Irrigation Channels to make use of the water noted above as available for storage.

New Tank
Project
near Sing
pura
(Site No. 24).

There is a site for another small tank on a tributary nullah rising in the hills, about a mile north of the village, and surveys for this will be prepared by Overseer Ram Chandar. The catchment area is about one square mile, all hilly, and allowing 20 per cent. of rainfall 14 m.c.ft. should be available for storage, sufficient for 140 acres, which should benefit Singpura and Harakheri villages.

Betuna
Nullah.

The Betuna nullah was next inspected, but nothing appears feasible on this. Between Betuna and Karawan there is a large area of grass land, intersected with small shallow nullahs flowing from west to east to join the main nullah.

Low earthen embankments could be put across each of these, at little cost, to hold up water in the rain, and the beds of the "naddis" so formed could all be cultivated with gram and wheat as the water percolated into the soil.

26. Khandar is $2\frac{1}{2}$ miles south of Karawan, and the dam constructed across the nullah at this village was inspected on 12th February. The work was carried out by the Tehsil, according to plans prepared by Assistant Engineer Abdur Rahman. The dam is of earth, 12 chains in length, top width 8 ft. 3 to 1 front slope pitched and 2 to 1 rear slope; there are natural weirs at both ends, the ends of the dam being pitched.

Khandar
Tank
(Site No. 25).

There is no sluice, and the tank was constructed to benefit the wells below, and this it has done; but the weir level is not high enough to command the land below, which is very high. As, however, there is a large area of good land below, it is thought it would pay well to make a large tank here, extending the dam to the south-east across the Jalni nullah, giving a total catchment of $8\frac{3}{4}$ square miles; and as a great part of this is hilly, we may allow 15 per cent. of rainfall as available for storage or 92 m. c. ft. of water. As the land below is high, all this would not be available for irrigation, and a part would lie in the low basin by Khandar village, and be useful for the villagers and cattle, and would benefit all the wells below. The higher portion of the bed would all be cultivated as the water receded as used for irrigation. Surveys for this will be made by Sub-overseer Pars Ram, and Plans and Estimate prepared. From flying levels taken the dam will have to be extended about 2,200 ft. to raise the present weir level 10 ft., and the land on right bank between Nathokheri and Pagaria will be commanded.

27. The next nullah south is the one which issues from the hills by Rajpura village and flows into the Kesri Naddi half a mile below and to the east of the village.

Rajpura.
Project
(Site
No. 26).

On this nullah, west of Rajpura, there is a good site for a tank, the dam starting on the right bank from the hill on the south on which Pitapura village stands, crossing to the hill on the left bank at the foot of which the nullah flows, and just below the point where a large nullah joins it on the left bank. The catchment is all hilly and $3\frac{1}{2}$ square miles so that 20 per cent. of rainfall should be stored, or 49 m.c.ft. of water, sufficient for 490 acres = 1,225 bighas. The dam will be about 1,500 ft. long; a masonry core-wall will be required for the whole length, as the soil is black, mixed with stones, no rock was visible in river bed, and the hills were of boulders and earth. The weir will be on the left bank, cut out of the hill as far as possible.

Three wells will be submerged, 10 bighas of irrigated land, and about 80 bighas of barani.

There is another site above, which would save these wells, and submerge only about 60 bighas of barani, but it would reduce the catchment to $2\frac{3}{4}$ square miles, a loss of $10\frac{1}{2}$ m.c.ft. of water and 105 acres of irrigation. Surveys will be made and Estimates for both will be prepared, and the Durbar can then decide which to take up.

The irrigation channel after Rajpura village would have to cross the nullah by an aqueduct—as here it runs in very deep banks—to the land of Binni village on the left, where there is a large area available for irrigation.

Baipur Project not recommended.

28. Another site was shown us south of Baipur where the Kesri naddi flows between the hills, about 2,000 ft. apart. This is probably the site referred to by Mr. Tickell as No. 12 in his Appendix E. The river is a large one running in deep banks, and though the dam would be about 2,000 ft. long (not 10,000 as noted by Mr. Tickell) it would have to be a high one with core-wall, or face-wall, and it would be a very expensive project and beyond the requirements of the Jhalawar State, as the land commanded is on the left bank only, and is the same that the proposed tanks at Rajpura and Khandar will irrigate.

The project is consequently not recommended.

Benaiga Project (Site No. 27)

29. At Awar a large nullah joins the left bank of the Au river. This nullah rises about 9 miles south of Awar, near Harnaunda, and flows northward.

About $3\frac{1}{2}$ miles from its source it passes Benaiga village, where there is a very good site for a storage reservoir. Mr. Tickell mentions this as No. 13 in Appendix E. of his Report, and surveys were made some years ago under his directions; but the line surveyed was for a dam across a tributary nullah only, which joins the main nullah on the left bank just above Benaiga village. This has only a catchment of 1 square mile. The line was not daghbelled, nor were any bench marks available, so all the Surveys will have to be made again (see para. 12). It would, it is thought, be better value to dam the main nullah, with its larger catchment of 4 square miles, which should give 42 m.c.ft. for storage, allowing 15 per cent. of rainfall; and the Irrigation Channels could be taken along the valley on either side the nullah to irrigate Goraria land, as well as Benaiga. The site is a good one, and the Project should not be expensive, as though a core-wall would be necessary the dam would not be a high one. There is a very good basin, at present grass land, and all this could be cultivated with wheat. Surveys for both projects will be carried out, and Plans and Estimates prepared, but the larger project is strongly recommended.

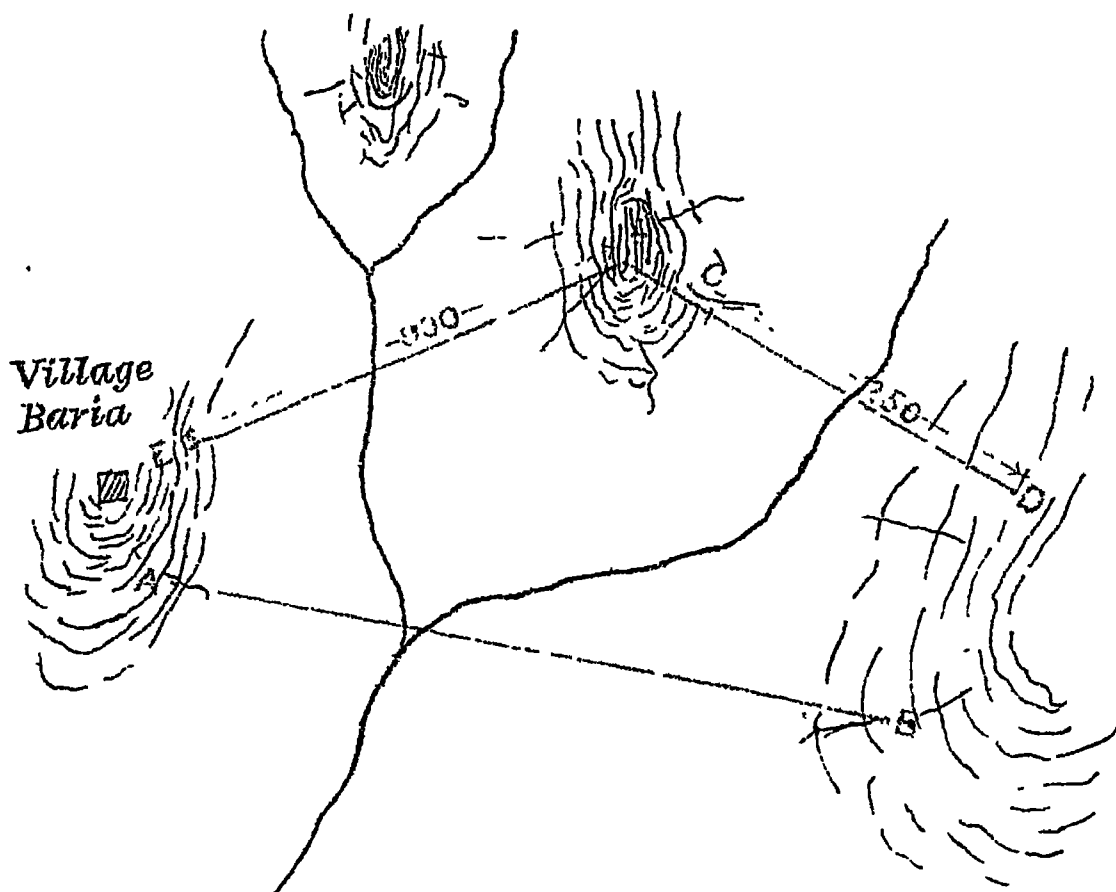
Weir at Jadni (Site No. 28).

30. Lower down this nullah, at Jadni—a Jagir village $1\frac{1}{2}$ miles south of Awar—there is an excellent site for constructing a masonry weir across the river to hold up water which could be lifted by odies on to the fields on either side. There is a rock bed, with large rock boulders above, and rock on either bank so that the flood water spilling on this would do no harm. The weir would only be 200 ft. long, and 8 ft. greatest height, so would not cost more than Rs. 1,000 and a fine pool would be held up.

Baria Project (Site No. 29).

31 Further east there is another tributary nullah to the Au river, and the two branches which form this stream rise in the hills to the south-east of Baria, and unite at that village. It would be possible to make a dam just below their junction from the hill on which Baria village

stands across to the hill on the left bank, line A B, but this would submerge 8 wells and 40 bighas of irrigated land, besides about 150 bighas of "mal." It would be better therefore to make two dams, as there is a low range of hills dividing the two, *viz.*, C D and E F,



and surveys and Plans and Estimate will be prepared, as there is good land below, and irrigation can be extended to Gajarni (K) and Khera (K) villages.

The catchment area of C D is 1 square mile, so we should be able to store 14 m.c.ft. of water, allowing 20 per cent. of rainfall. About 50 bighas of "mal" land will be submerged by this tank, but no wells or irrigated land, and the bed will all be cultivated as the water recedes.

The catchment area of E F is also 1 square mile, giving us 14 m.c.ft. of water; and in this tank only 15 bighas of "mal" will be submerged. Mr. Tickell suggests a tank at Baria, *vide* No. 23 in Appendix E. of his Report.

32. The country south of the Kasri naddi is hilly and undulating and stoney; the culturable land is limited and lies in patches in the valleys near the villages, which are scattered. Though there are many sites where dams could be constructed, many of these are useless for want of land below. This applies to a site about 1 mile west of Malpura village which was inspected on 13th February, at the request of the Political Agent, as many Patels had asked for its construction.

Malpura
(Site No. 30).

The Patels who met me were most anxious for its construction, as they said it would benefit wells in several villages which they named, such as Bhain Sagar, Chandarpura, Malpura, which however are not on this nullah at all, nor are their lands in the same catchment, so could not possibly be affected.

There is hardly any culturable land below the site, nor wells on the nullah itself, and the project is therefore not worth further consideration.

Another site to the east of Malpura was also shown me. This is better than the last, as there is more land below, but it is undulating ground and intersected, and the Irrigation Channels would be troublesome to construct, and I do not think the project would pay, or is worth taking up.

Poula Pro-
ject
(Site No. 31).

33. Two miles south-west of Harmauda is the village of Poula, and one of the tributaries of the Au river rises in the hills $2\frac{1}{2}$ miles south-east of this village, and flows past it in a north-west direction.

This was inspected on 14th February, and there is a good site just above the village for constructing a dam, which would be about 900 ft. long, and has a hilly catchment of $2\frac{1}{2}$ square miles, capable of storing 35 m.c. ft. and irrigating 350 acres.

This was roughly surveyed in 1892-93, but nothing further seems to have been done, and it is not mentioned by Mr. Tickell.

Poula is a khalsa village, with about 12 wells which irrigate 30 bighas; and there is about 60 bighas of good land unirrigated.

Lower down there is the village of Pouli, the lands of which would also be commanded by the tank, so its construction is recommended, and surveys, Plans and Estimate will be prepared.

Lowaria.
(Site No. 32).

34. Crossing the hills south-east we came to Lowaria, where there is another tributary nullah of the Au.

A tank of this village is suggested by Mr. Tickell, as No. 14 in Appendix E. of his Report.

There is a site above the village where a tank could be constructed, but it is not required, or wished for by the villagers, as it would submerge about 200 bighas of "mal" land, which are cultivated in the Kharif; and below the only land is already irrigated from wells (kutchas) of which there are about 50 in use. Water is about 25 ft. below surface, and the villagers informed me never gave out.

Mangalia
Project
(Site No. 33).

35. We then crossed the hills to the south-west to Mangalia, a Khalsa village, on the slope of a high hill, where in old days was a fort.

Three nullahs rise in the hills to the west and south of the village, opposite which they join, and flow onwards in an easterly direction to the Au.

Mangalia possess about 25 wells, irrigating about 80 bighas, and has also about 300 bighas of "mal", land unirrigated. There are small villages lower down the valley, which are Jagir.

Three lines for a dam suggest themselves :—



- (a) "A B" to dam all 3 nullahs, with a hilly catchment of $2\frac{3}{4}$ square miles, giving $38\frac{1}{2}$ m.c.ft. of water for storage.

This would submerge 2 wells, one belonging to Gobindpura village, and the other to Mangalia, and 26 bighas of irrigated and about 150 bighas of "mal," cultivated in the Kharif. The land below is not sufficient to compensate for this, so this line may be neglected.

- (b) "C B," which dams two nullahs, with a catchment of $1\frac{1}{2}$ square miles and possible storage of 21 m.c.ft. This only submerges about 125 bighas of "mal" land, a great portion of which would be cultivated with wheat as the water receded.

- (c) "D E." This only dams one nullah, with a catchment of $\frac{3}{4}$ -square mile, and possible storage of $10\frac{1}{2}$ m.c.ft; with this about 50 bighas of "mal" land will only be submerged. This is the site the villagers themselves want, and say is sufficient for their own requirements.

Surveys and Estimates and Plans for both "C B" and "D E" will be prepared, and the Durbar can then decide which should be carried out as most advantageous to the State, irrespective of the requirements of Mangalia village alone.

36. Mr. Tickell (No. 15 of Appendix E) suggests a tank at Dug. The old tank, which is the only one with a catchment approaching 6 square miles, the figure given by Mr. Tickell, breached 100 years ago, and nearly 50 wells, irrigating 300 bighas, have been constructed in the bed, and there are also about 900 bighas of "mal" land cultivated in the rains. Closing the breach would therefore do nothing but harm.

Dug.

There is, however, a site (Site No. 34) where a tank might be constructed at little cost and with great benefit, about a mile to the south of Dug town, across the valley at the head of which is Girdarpura village.

This is all barani land, partly cultivated in the rains, and the water of the nullah in the centre of the valley passes away in the rains and is lost.

An earthen dam is all that is required, starting from the low hill, on the west of the road to Chokri Chota, on the right bank of the nullah, across to the high ground on the left.

There is plenty of good land below, all of which could be irrigated, and the bed of the tank itself would all be cultivated. The catchment area is 1 square mile, but can be increased to 1½ square miles as the nullah on the north of the site, and south of Dug city, could easily be diverted into the catchment by constructing a short bund, with a cut through the ridge above it.

This is a most promising project and should pay well. If not carried out before it would form an excellent relief work, whenever these should have to be again opened.

Surveys, Plans and Estimate will therefore be prepared.

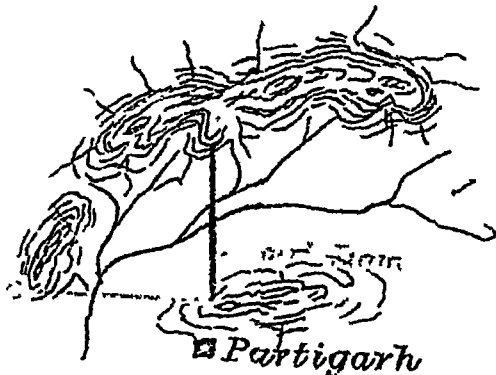
Chota
Chokri
(Site No. 35).

37. A tank was suggested here by Mr. Tickell (No. 16 in his Appendix E), and from the topographical Survey Map looked a good site.

It was inspected on 14th February, but is not feasible, as if constructed the tank would submerge all the wells and irrigated land of the village, and leave very little land below, which is at present jungle and uncultivated. There is a fine valley of "mal" land above and east of the village, and this could only be commanded by a tank formed by constructing a dam between the Chokri Bara hill on the left bank and the Jagirpura hill on the right, where a very fine tank could be formed, but these are Jagir villages and the tank would submerge their valuable irrigated land, so is really not to be considered.

Partigarh
(Site No. 36).

38. The nullahs north-west of Dug were inspected on 15th February. At Partigarh, 2½ miles north-west of Dug, there are the remains of an old earthen dam, across a nullah issuing from the hills north of the village, which has been lying breached for years. The villagers are very anxious for this dam to be restored, line "A B"; but it would be better to alter the line to "A C," to take in another nullah and enlarge the catchment by ¼ square mile, as the cost of constructing



either will be practically the same. "A. C" will submerge 1 kutchu well and 4 bighas of land irrigated from it, but the extra catchment should bring in an additional 3½ m.c.ft. of water, sufficient to irrigate 35 acres, so that the advantages outweigh the disadvantages.

Partigarh has 36 wells irrigating 130 bighas, but there are also nearly 400 bighas of "mal" land unirrigated, so the larger the tank the better. Surveys for this will be made and Plans and Estimate prepared.

39. The two main nullahs, of which the Partigarh nullah is one of the many tributaries, unite below Dadalai village, and here a very large tank, with a catchment of 13 square miles, capable of storing 91 m.c.ft., could be constructed. Dadalai
Project
(Site No. 37).

The project would be an expensive one. The dam would be a mile in length, starting from the hill on the left bank in the south to the small hill by Dadalai village on the right bank, and continued on the other side to the north till high ground and another low hill is reached; and as the nullahs run in deep banks, and the land on either side forming the bed is high, a high dam would be required.

Though there is a large area of "mal" land in the bed, which is at present only cultivated in the Kharif, and which would produce wheat if the tank was constructed, it is doubtful if there is sufficient land below for so large a project, and there are certainly not enough cultivators at present, so that it does not seem worth while making surveys. If, as I was informed, kutchha wells only cost Rs. 25 to construct, and yield a revenue of Rs. 9 per annum (each well can irrigate 3 bighas), it would, it is thought, pay the State well, provided cultivators are available, to construct a large number of wells in this basin.

In the existing wells water appears to be about 30 ft. below the surface, and about 10 ft. deep.

40. Further west, at Jamunia, there is a good site for an earthen dam, about 1 mile long, across the valley and above the village, connecting the hills on either side. Jamunia possesses about 18 wells irrigating about 40 bighas of land; these would be below the dam, and there is a large area of good land also, about 800 bighas, available for irrigation. No good land would be submerged. The catchment area is $3\frac{1}{4}$ square miles, sufficient to supply $22\frac{3}{4}$ m.c.ft. of water for storage, at 10 per cent. of rainfall. This should be a paying project, and Surveys, Plans and Estimate will be prepared. Jamunia
Project
(Site No. 38).

Mr. Tickell suggests a tank here, No. 18 of Appendix E.

41. Mr. Tickell suggests a tank at Kuchnia (No. 19 Appendix E), and the nullah which flows past this village was inspected from Nawalkhera downwards. Kuchnia
Project
(Site No. 39).

Nothing, however, appears feasible here, nor is a tank required at Kuchnia, as the wells here are good, 5 wells irrigating 60 bighas.

42. At Rojana, $2\frac{1}{2}$ miles north-west of Kuchnia, the condition of the wells is different, and the water in them has fallen considerably, and out of the 40 wells belonging to the village only 30 are in use and irrigate on an average $1\frac{1}{2}$ bighas each. The villagers are therefore most anxious for a small tank to be constructed at the head of the nullah above the village as they feel sure this will benefit the wells. The site was shown me, but the catchment is very small, not more than a $\frac{1}{4}$ -mile. The Assis- Rojana.
(Site No. 40).

tant Engineer should make the necessary surveys, and the work might be sanctioned to be carried out by the Tehsil. There is rock in the nullah bed, and the soil on either bank is stoney, so a core-wall will be necessary.

Tanks not
necessary
in the
Gangrar
Tehsil.

43. The soil in this Tehsil is much more rocky than in the rest of the State, and even where there is "mal" land the greater portion has no depth, the rock being close to the surface; and where this occurs only Jowar can be grown in the rains; the soil is not good enough, I was told, to produce wheat, even if irrigated: so that tanks are of little use, as the irrigable land is small in area.

Where good "mal" land fit for irrigation is found near the villages, opium is the crop the villagers cultivate, and are accustomed to; and this, I am also informed, cannot be irrigated from tanks, as tank water is too cold and the warmer water of wells can alone be used.

Small tanks, such as that asked for at Rojana to benefit the wells, appears to be all that is required in this Tehsil.

Chota Kalisind River.

44. In Appendix E. of his Report (No. 20) Mr. Tickell writes: "The Chota Kalisind river which passes near Gangdhar and has a drainage area of about 900 square miles might be bunded up near Sarwar and the irrigation of nine villages could be effected by two canals, totalling about 20 miles. The Kharif irrigation could be done by the natural flow of the river and the tank reserved for the rabi."

On 17th February I inspected the country on right bank, riding from Gangrar to Sarwar via Sonari, Sekla, and Barlia villages, crossed the river at Sarwar, returning by Sari, Berla and Pipakhera villages on the left bank of the river.

At Sarwar the river is 350 ft. wide, the right bank is 55 ft. high, and the left 35 ft., and throughout its course it runs in deep banks till it widens out above Gangrar, where it is over 700 ft. wide with banks about 18 ft. high. The country that would be irrigated, if a dam was formed as proposed by Mr. Tickell, is therefore very high; it is also broken up by cross drainage, and the good irrigable land is limited in extent, and the larger part of the land commanded is stoney and unprofitable.

There is no site for a dam at or near Sarwar, and any project on so large a river would be very expensive, and a large quantity of the water stored would be in the bed of the river itself and useless for irrigation.

Mr. Tickell's proposal is therefore, in my opinion, not feasible.

Tank on
Nullah
between
Sekla and
Barlia Vil-
lages
(Site No. 41).

45. The only thing to do is to try and make use of the tributary nullahs, and these appeared a good site for a small tank on the nullah which passes between Sekla village on the north and Barlia on the south.

The catchment is $1\frac{1}{2}$ square miles, rocky, hard soil; so quite 15 per cent. of rainfall would be stored, or 16 m c.ft. The basin is good, and consists of unculturable soil, but just below there is a stretch of barani land, on which Jowar is now grown in the Kharif, belonging to Padmakheri village. This would all be commanded and wheat could be produced. The Assistant Engineer might make further investigations, and if the project is approved by the revenue authorities, have surveys made and prepare necessary Plans and Estimate.

46. At Jaitakheri, a mile north-east of Gangrar, there are two tanks, built many years ago. The larger, "Dilsagar," is half a mile to east of the village, and the small "Nanka" tank at the village itself. Neither has any sluice, and this year the water was being lifted from the "Dilsagar" and carried by a trench across the bund to irrigate a small area below.

Tanks at
Jaitakheri
(Site No. 42).

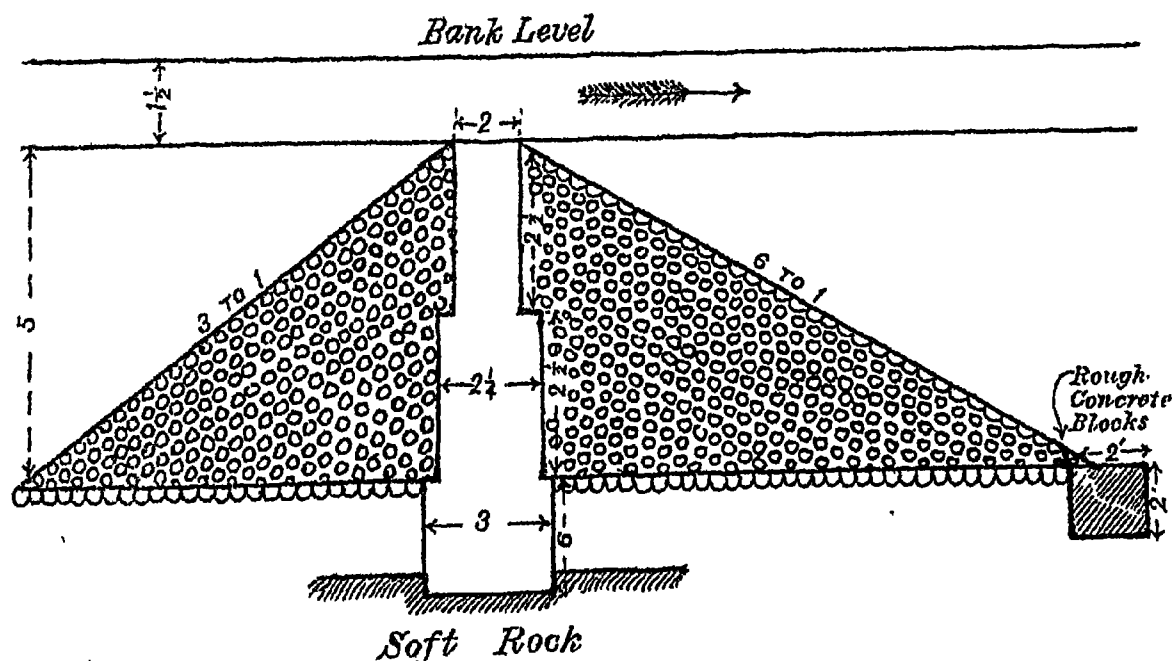
But a sluice and irrigation channels could be constructed at little cost, and as there is land below which could be irrigated and is at present not used, it would, it is thought, be worth while having this done; and the Assistant Engineer might prepare an estimate for the same.

47. Mr. Tickell proposes a tank at Dokar Kheri (No. 22 Appendix E), a village 6 miles south-west of Gangrar. This was inspected on 18th February. The village is a small one, and possesses 5 wells, and a few "odis" on the edge of the nullah, and 400 bighas of "mal" land, of which 50 can be irrigated if all the wells are in use. This year, owing to scarcity of water, only 3 wells are in use, and 10 bighas of land irrigated. The land on either side the nullah is very stoney, and the 400 bighas noted above are all that is available for irrigation.

Dokar-
kheri
(Site No 43).

Though a tank could be formed above the village, the basin is narrow, and the land rises quickly on either side, so that it would necessitate a comparatively high dam, and would not pay; but something should be done to help the wells and "odis," and benefit the village, and a weir might be constructed at little cost below the village to hold up the water.

The weir would be about 100 ft. long and 5 ft. high. The sketch shows what is proposed, a wall of stone in line in the centre forming a backbone, founded well into the soft rock, which is found about 5 ft. below the nullah bed, and taken into each bank about 15 ft. to prevent water cutting round, and a front slope of boulders 3 to 1, with rear slope of 6 to 1, consisting of very large stones, with heavy blocks of rough concrete at toe, to prevent rear slope sliding.



If it is found after excavating that the substratum of rock can be depended upon, it might perhaps cost less to make a "pucca" weir at once, the masonry being thicker than the core-wall proposed, with a water cushion, the bottom of which would be on the rock below, between the concrete blocks and the weir, the concrete blocks being brought nearer to the weir, say 15 ft. distant only.

The Assistant Engineer might prepare alternative Estimates for these.

Semli
(Site No. 44)

48. At Semli, a village 8 miles north-west of Gangrar, Mr. Tickell has also a proposal for a tank (No. 21 Appendix E). This was inspected on 18th February. Semli is a very small village of 6 houses, and there are only 3 cultivators in the village. Though there is a good catchment area for a tank, there is practically no land to irrigate, as there is high stoney land on either side, the valley contracting below Semli village, which has only 22 bighas of irrigable land altogether; and Chipria, the village below on the nullah, has only 40 bighas.

But Semli village also wants assistance, as this year only 4 of the 7 wells are in use, and 15 bighas of land irrigated for want of water.

Here also I would suggest that a weir should be built just below the village, at a site pointed out to the Assistant Engineer, to hold up water for the benefit of the wells and which might be also raised by odis. There is rock in the river bed, and the nullah is 100 ft. wide from top of bank to bank. The weir should be similar to that proposed for Dokarkheri, and should not cost more than Rs. 200 to construct.

Summary
of Investi-
gation.

49. *This completes the Investigation, as nothing more seems possible in this Tehsil, in which though there are plenty of nullahs there seems little means of making use of them, except as suggested by weirs at the villages to assist the wells, as the irrigable land is so limited, and the villages so small and sparsely populated.*

The following is therefore the list of projects which are recommended and for which surveys will be made, and Plans and Estimates prepared:—

PATAN TEHSIL.

- (1) Shamia.
- (2) Ram Nawas Ghatod.
- (3) Rewa River Project at Khod.

PANCHPAHAR TEHSIL.

- (4) Gunjpura.
- (5) Naka Sarna near Guraria

AWAR TEHSIL.

- (6) Gugwa.
- (7) Sin:pura.
- (8) Khandar.
- (9) Rajpura.
- (10) Baria (2 Tanks).
- (11) Benaiga (2 Tanks).

DUG TEHSIL.

- (12) Poula.
- (13) Mangalia (2 sites).
- (14) Dug (1 mile south of town.)
- (15) Partigarh.
- (16) Jamunia.

In addition to these the following have been suggested to the Assistant Engineer who says he can have them worked out locally, and if when they are being prepared I can give any assistance, I shall only be too glad to do so:—

PATAN TEHSIL.

- (1) Sarangakheri—Revised Project.
- (2) Jarer.
- (3) Motipura—Estimate to be revised.

PANCHPAHAR TEHSIL.

- (4) Ratanpura.
- (5) Sarod.
- (6) Deori Feeder.
- (7) Estimate for completion of Hatunia Tank.

GANGRAR TEHSIL.

- (8) Rojana.
- (9) Barlia.
- (10) Weir at Dokarkheri.
- (11) Sluice and Irrigation Channels to Dilsagar at Jaitakheri.
- (12) Weir at Semli (Galot).

When these are worked out, the Durbar will have a large programme available, to be carried out gradually; and when completed the State should be fairly well protected against Famine.

To make full use of what is proposed, more cultivators are required; with these obtained the State should derive great financial benefit from the works proposed, in addition to their protective value.

A fixed sum should be set aside for carrying out what is suggested, and any work decided on and sanctioned should be finished right through, including Irrigation Channels, before another is started, so that a return on the expenditure incurred may be derived from each as soon as possible.

It is no use starting a number and leaving them half finished. If a large work is decided on, which will take up the grant for 2 or 3 years, no other new work should be started till that is completed; but in the present condition of the finances and population it is thought small works should first be carried out, and with the opening of the railway, if land on most lenient terms at first is offered, it is hoped that cultivators from outside will see the natural advantages of the soil and come to settle in the State, and the demand for land and water will necessitate the execution of the larger works proposed.

F. ST.-G. MANNERS SMITH,

SUPERINTENDING ENGINEER,

Protective Irrigation Works, Rajputana.

AJMER,

February 1905.



